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NSB KINGS BAY  
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INTERIM CORRECTIVE MEASURE SCREENING INVESTIGATION REPORT, VOLUME I  
SECTIONS 1 THROUGH 8 NSB KINGS BAY GA  
8/1/1993  
ABB ENVIRONMENTAL

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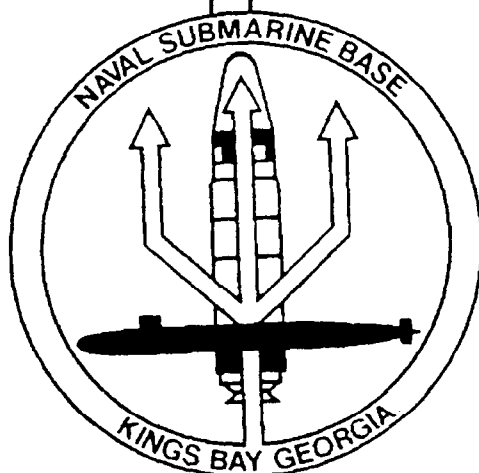


**INTERIM CORRECTIVE MEASURE SCREENING  
INVESTIGATION REPORT**

**VOLUME I - SECTIONS 1 THROUGH 8**

**NAVAL INSTALLATION RESTORATION PROGRAM  
NAVAL SUBMARINE BASE  
KINGS BAY, GEORGIA**

**CONTRACT NO. N62467-89-D-0317**



**SOUTHERN DIVISION  
NAVAL FACILITIES ENGINEERING COMMAND  
NORTH CHARLESTON, SOUTH CAROLINA  
29418**

Response to Comments from Georgia Department of Natural Resources on the Draft Final Interim Corrective Measure Screening Investigation Progress Report, Naval Submarine Base, Kings Bay, Georgia

Comment Number	Section/Paragraph	Comment	Response
1	Signatory Requirements	<p>The report was not properly submitted. As required under the terms of Hazardous Waste Facility Permit HW-014(S) (2), Section I.C.8., "all reports or other information requested by the Director shall be signed and certified according to the requirements in 270.11" of 40 CFR, which requires that the following certification, made by a responsible party, accompany the report: "I certify under penalty of law that this document and all attachments were prepared under my direct supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." This certification must be submitted for inclusion in the report.</p>	<p>The required certification will be included in the Final ICMS Report.</p>

Response to Comments from Georgia Department of Natural Resources on the Draft Final Interim Corrective Measure  
Screening Investigation Progress Report, Naval Submarine Base, Kings Bay, Georgia

Comment Number	Section/Paragraph	Comment	Response
2	Signatory Requirements	This report was not signed and sealed by a Georgia registered Professional Geologist. Under Georgia Law, the Registration of Geologists Act of 1974, all geologic work performed in the public practice of geology must be prepared and approved by a Georgia registered Professional Geologist or a subordinate working under his direction, and must be signed and sealed by said geologist. Failure to comply may result in the rejection of the geologic work by EPD. This certification must be submitted for inclusion in the report.	The Final ICMS Report will be signed and sealed by a Georgia register Professional Geologist.
3	Section 1.1	A topographic map of an appropriate scale, showing the site location, should be included in this section.	Each copy of the Final ICMS Report will contain either an original or a reproduction of a USGS topographical quadrangle map (Harriett's Bluff, GA) having a scale of 1:24,000. The NSB and Site 11 will be shown on each map.
4	Section 2.5	The materials used in the Grab Sampler III, manufactured by Wheaton Instruments, should be specified. (This instrument was not listed in the RFI workplan).	Section 2.5 will be revised to include this information.

Response to Comments from Georgia Department of Natural Resources on the Draft Final Interim Corrective Measure  
Screening Investigation Progress Report, Naval Submarine Base, Kings Bay, Georgia

Comment Number	Section/Paragraph	Comment	Response
5	Section 2.7	Investigation-derived waste (IDW) collected from the decontamination area is not being handled in accordance with the procedure described in the RFI workplan submitted in October, 1991. Also, the disposal of this waste does not conform to the USEPA Guide to Management of Investigation-Derived Wastes (USEPA 1992). The decontamination water is considered non-indigenous IDW and may contain contamination that was not present when activities began on the site (e.g. solvents used for decontamination). In the future, IDW must be appropriately handled.	Management of IDW resulting from future RFI or IM activities at the site will be addressed in the Supplemental RFI planning documents currently in progress.
6	Section 4.2	This section should be revised to include a description of the method used to calculate hydraulic conductivity values from the piezocone data.	Section 4.2 will be revised to indicate that the rate of filling of the 6.5-foot long hydrocone sample chamber was recorded by the computer. These data were plotted to estimate permeability at specific intervals in the aquifer. The calculations were performed using Hvorslev's Basic Time Lag Method.

Response to Comments from Georgia Department of Natural Resources on the Draft Final Interim Corrective Measure Screening Investigation Progress Report, Naval Submarine Base, Kings Bay, Georgia

Comment Number	Section/Paragraph	Comment	Response
7	Section 4.3.1	This section should state whether or not the fountain in Porcupine Lake is in operation.	Section 4.3.1 will be revised to indicate that the fountain has not been observed in use by residents of Crooked River Subdivision for several years.
8	Section 5.2 Paragraph 2, page 5-5	The Georgia Rules of Hazardous Waste Management should be included in the ARAR's for NSB Kings Bay. Paragraph 2 on page 5-5 should read "Georgia Hazardous Waste Management Rules are applicable when developing appropriate cleanup standards."	Section 5 will be revised to include the Georgia Rules for Hazardous Waste Management as an applicable ARAR in Table 5-1, Chemical Specific ARARs. (Note: No chemical specific ARARs were found in the Georgia Rules for Hazardous Waste Management.) Additionally, the second paragraph of page 5-5 will be revised to include a lead-in sentence indicating that the Georgia Rules for Hazardous Waste Management are applicable when developing appropriate cleanup standards at the site.
9	Section 5.2 Table 5-1	Table 5-1 contains a reference to "RCRA Subpart F-Groundwater Protection Standards (40 CFR 254.94)". This should be revised to read "40 CFR 264.94".	Table 5-1 will be revised to correct the reference to 40 CFR 254.94 to 40 CFR 264.94.

Response to Comments from Georgia Department of Natural Resources on the Draft Final Interim Corrective Measure  
Screening Investigation Progress Report, Naval Submarine Base, Kings Bay, Georgia

Comment Number	Section/Paragraph	Comment	Response
10	Section 5.2 Table 5-1	Table 5-1 should be revised to include the Georgia Rules for Hazardous Waste Management.	See response to comment No. 8.
11	Section 6 Paragraphs 3 and 6	The term "unreasonable worst possible case scenario" should not be used. Terminology should reflect that one set of estimates is a result of assumptions of maximum possible exposure and one the result of a more central estimate of exposure.	The term "unreasonable worst possible case scenario" has been replaced with "maximum possible exposure" and the "more reasonable exposure" scenario has been described as the "maximum likely exposure" scenario.
12	Section 6 Table 6.5	Table 6.5 should also be revised to clarify whether different inputs were used for the daily intake via inhalation of vapors from spray water for the "reasonable" versus "unreasonable" case. The exposure factors for the "unreasonable" case were not included in the table.	The inputs used to calculate exposure to vapors released from the spray water were the same for both the "unreasonable" and "more reasonable" scenarios. Table 6-5 has been modified to provide all inputs used to calculate the exposures via this route.



The geologic work and professional opinions rendered in the Final Interim Corrective Measure Screening Investigation Report for Site 11, Naval Submarine Base, Kings Bay, Georgia were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice.



Eric G. Nelson

Professional Geologist No. 539  
Expires December 31, 1993

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
REPORT SECURITY CLASSIFICATION unclassified			1b. RESTRICTIVE MARKINGS N/A		
2a. SECURITY CLASSIFICATION AUTHORITY N/A			3. DISTRIBUTION/AVAILABILITY OF REPORT  N/A		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A					
4. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION  ABB Environmental Services, Inc.		6b. OFFICE SYMBOL (if applicable)  ABB-ES		7a. NAME OF MONITORING ORGANIZATION Naval Submarine Base, Georgia	
6c. ADDRESS (City, State, and ZIP Code)  1400 Centerpoint Blvd., Suite 158 Knoxville, TN 37932			7b. ADDRESS (City, State, and ZIP Code)  Public Works Department NSB, Code N 561 Kings Bay, Georgia 31547		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION SOUTHNAVFACENGCOM		8b. OFFICE SYMBOL (if applicable) N/A		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER  N62467-89-D-0317	
8c. ADDRESS (City, State, and ZIP Code)  2571 Eagle Drive P.O. Box 10068 N. Charleston, SC 29418			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.
11. TITLE (Include Security Classification)  Interim Corrective Measure Screening Investigation Report					
PERSONAL AUTHOR(S)  L. Harris, M. Dulaney, M. Carpenter, N. Weber					
13a. TYPE OF REPORT Final		13b. TIME COVERED  FROM 10/92 TO 1/93		14. DATE OF REPORT (Year, Month, Day) July 1993	
15. PAGE COUNT 265					
16. SUPPLEMENTARY NOTATION					
17. COSAT: CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)  VOCs, Site 11, Old Camden County Landfill, Screening Human Health Risk Evaluation		
FIELD	GROUP	SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number)  The Interim Corrective Measure Screening Investigation field program included an ambient air screening survey, collection of groundwater samples within the surficial aquifer, and collection of soil vapor, sediment, surface water, and private irrigation well (PIW) samples.  Continued in Block No. 19, Abstract					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT  <input type="checkbox"/> Unclassified/Unlimited <input type="checkbox"/> Same as RPT <input type="checkbox"/> DTIC Users			21. ABSTRACT SECURITY CLASSIFICATION  unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL Mr. Ed Lohr			22b. TELEPHONE (Include Area Code) (803) 743-0577		22c. OFFICE SYMBOL 182

REPORT DOCUMENTATION PAGE--continued

Form Approved  
OMB No. 0704-0188

Block No. 18, Subject Terms

Block No. 19, Abstract

The analytical program for the investigation included on-site laboratory analyses for 10 target VOCs using two gas chromatographs. A minimum of 10 percent of the groundwater and PIW samples, and all sediment and surface water samples, were submitted to an off-site laboratory for analysis of VOCs using Contract Laboratory Program (CLP) methods. Sediment, surface water, and three groundwater samples were also analyzed for semivolatile organic compounds (SVOCs). The off-site laboratory data was validated according to CLP criteria.

The air screening survey results for vinyl chloride do not indicate that "hot spots" are present in the subdivision. Results of the groundwater investigation indicate that the contaminant plume extends approximately 600 feet west-northwest of the NSB Kings Bay property line. VOCs were detected in groundwater at depths ranging from 11 to 57 feet below ground surface, and include chlorinated solvents, such as vinyl chloride, dichloroethene, trichloroethene, and tetrachloroethene, and fuel-related VOCs, such as benzene, toluene, ethylbenzene, and xylenes. No VOC or SVOC contaminants were identified in the sediment or surface water samples. SVOCs detected in groundwater samples collected from a location adjacent to the landfill include naphthalene and phenolic compounds.

Analysis of PIW samples indicates a potential for VOCs in irrigation water. Five of 51 PIW samples contained VOCs that are common to the plume, including vinyl chloride, cis-1,2-dichloroethene, and ethylbenzene.

The SRE evaluated potential carcinogenic and non-carcinogenic health risks to residents of Crooked River Plantation Subdivision due to exposure to potential contaminants of concern (PCOCs) via inhalation, dermal absorption, and incidental ingestion. Results of the SRE indicate the potential for non-carcinogenic health effects through dermal absorption and incidental ingestion of PCOCs. The results did not indicate that inhalation exposure poses unacceptable risks. Residents of Crooked River Plantation Subdivision should take measures to minimize these types of exposures by not using groundwater for such activities as filling swimming pools.

Recommendations are made for a confirmatory sampling program to be planned and implemented concurrently with an interim measure. The interim measure will include a pilot-scale groundwater extraction and treatment system. The confirmation program will focus on long-term corrective action goals and regulatory concerns for the site.

**FINAL**

**INTERIM CORRECTIVE MEASURE SCREENING INVESTIGATION  
REPORT**

**SITE 11**

**CONTRACT TASK ORDER NO. 041**

**MODIFICATION NO. 3**

**CLEAN DISTRICT 1**

**CONTRACT NO. N62467-89-D-0317**

**VOLUME I**

**NAVAL SUBMARINE BASE  
KINGS BAY, GEORGIA**

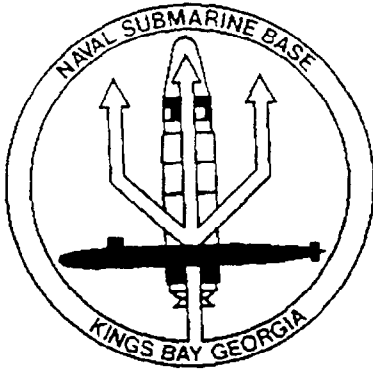
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**August 1993**



## FOREWORD

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), the 1976 Resource Conservation and Recovery Act (RCRA), as augmented by the 1984 Hazardous and Solid Waste Amendments (HSWA), and as directed in Executive Order 12580 of January 1987, the Department of Defense (DOD) conducts an Installation Restoration (IR) Program for evaluating and remediating problems related to releases and disposal of toxic and hazardous materials at DOD facilities.

The Naval Assessment and Control of Installation Pollutants (NACIP) program was developed by the Navy to implement the IR Program for all Naval and Marine Corps facilities. The NACIP program was conducted originally in three phases: (1) Phase I, Initial Assessment Study, (2) Phase II, Confirmation Study (including a Verification Step and a Characterization Step), and (3) Phase III, Planning and Implementation of Remedial Measures. The three-phase IR Program was modified and updated to be congruent with the CERCLA/SARA and RCRA/HSWA-driven DOD IR program.

The updated nomenclature for the RCRA/SARA process is as follows:

- Preliminary Assessment and Site Inspection
- Remedial Investigation
- Feasibility Study
- Planning and Implementation of Remedial Design

This report discusses the findings and results of an Interim Corrective Measure Screening Investigation conducted at Naval Submarine Base (NSB), Kings Bay, Georgia. This investigation included characterization of the nature and extent of volatile organic compounds in groundwater associated with Site 11, Old Camden County Landfill, at NSB. Groundwater analytical data were used to perform a human health screening risk evaluation.

Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) has the responsibility for implementation of the Navy and Marine Corps IR Program in the southeastern and midwestern United States. Questions regarding this report should be addressed to the NSB Public Affairs Office at (912) 673-4714.

## EXECUTIVE SUMMARY

This Interim Corrective Measure Screening Investigation Report was prepared for Site 11, the Old Camden County Landfill, located on the Naval Submarine Base (NSB), Kings Bay, Georgia. The objectives of the Interim Corrective Measure Screening Investigation included delineation of the horizontal and vertical extent of volatile organic compound (VOC) contaminants in groundwater in the area of the landfill and in the Crooked River Plantation Subdivision. Data were also collected to support a screening risk evaluation (SRE). The Interim Corrective Measure Screening Investigation field program included an ambient air screening survey, collection of groundwater samples within the surficial aquifer, and collection of soil vapor, sediment, surface water, and private irrigation well (PIW) samples.

The analytical program for the investigation included on-site laboratory analyses for 10 target VOCs using two gas chromatographs. A minimum of 10 percent of the groundwater and PIW samples, and all sediment and surface water samples, were submitted to an off-site laboratory for analysis of VOCs using Contract Laboratory Program (CLP) methods. Sediment, surface water, and three groundwater samples were also analyzed for semivolatile organic compounds (SVOCs). The off-site laboratory data were validated according to CLP criteria.

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Recommendations are made for a confirmatory sampling program to be planned and implemented concurrently with an interim measure. Both studies will be solution-oriented. The interim measure will include a pilot-scale groundwater extraction and treatment system. The confirmation program will focus on long-term corrective action goals and regulatory concerns for the site.

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## LIST OF ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
ACGIH	American Conference of Governmental Industrial Hygienists
ACL	alternative concentration limit
ADD	average daily dose
AIC	Applicable Intake - Chronic
AIS	Applicable Intake - Subchronic
ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
BFB	bromofluorobromine
bgs	below ground surface
B&K	Brueel & Kjaer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMS	Corrective Measure Study
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CLP	USEPA Contract Laboratory Program
cm <sup>2</sup>	square centimeters
cm/sec	centimeters per second
CRQL	Contract Required Quantitation Limit
CS	Confirmatory Sampling
CSFs	Cancer Slope Factor
CWA	Clean Water Act
DNR	Department of Natural Resources
DOD	Department of Defense
DQO	Data Quality Objective
EPCs	Exposure Point Concentrations
FS	Feasibility Study
ft/yr	feet per year
gal/day/ft <sup>2</sup>	gallons per day per square foot
GA DNR	Georgia Department of Natural Resources
GC	gas chromatograph(y)
gpm	gallons per minute
HEA	Health Effects Assessment
HI	Hazard Index
HRS	Hazard Ranking System
HSWA	Hazardous and Solid Waste Amendments
IR	Installation Restoration
IRIS	Integrated Risk Information System
kg	kilograms

LIST OF ACRONYMS (continued)

LADD	lifetime average daily dose
m/yr	meter per year
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDL	Method Detection Limit
ml	milliliter
MLW	mean low water
MS/MSD	matrix spike/matrix spike duplicate
$\mu\text{g/kg}$	micrograms per kilogram
$\mu\text{g/l}$	micrograms per liter
$\mu\text{g/m}^3$	micrograms per cubic meter
$\mu\text{mhos/cm}$	micromhos per centimeter
NAAQS	National Ambient Air Quality Standards
NACIP	Naval Assessment and Control of Installation Pollutants
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NESHAP	National Emission Standard for Hazardous Air Pollutants
NPL	National Priorities List
NSB	Naval Submarine Base
OSHA	Occupational Safety and Health Administration
%R	percent recovery
PA	Preliminary Assessment
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCOCs	Potential Contaminants of Concern
PIW	private irrigation well
ppm	parts per million
PTA	packed tower aeration
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RA	Risk Assessment
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RFA	RCRA Facility Assessment
RfDs	Reference Doses
RFI	RCRA Facility Investigation
RI	Remedial Investigation
ROD	Record of Decision
RPD	relative percentage difference

LIST OF ACRONYMS (continued)

SARA	Superfund Amendments and Reauthorization Act
SC	Site Closure
SDWA	Safe Drinking Water Act
SI	Site Inspection
SOUTHNAVFACENGCOM	Southern Division, Naval Facilities Engineering Command
SOW	Statement of Work
SQL	Sample Quantitation Limit
SRE	Screening Risk Evaluation
STEL	Short Term Exposure Limit
s.u.	standard unit
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TBC	to be considered
TCL	Target Compound List
TLV	Threshold Limit Values
TS	Treatability Study
TWA	time weighted average
UCL	Upper Confidence Limit
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds
WOE	weight of evidence

## 1.0 INTRODUCTION

Under contract to the U.S. Department of the Navy (Navy) Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), this Interim Corrective Measure Screening Investigation Report was prepared for Site 11, the Old Camden County Landfill, located on the Naval Submarine Base (NSB) in Kings Bay, Georgia. This report was prepared under the Navy's Comprehensive Long-term Environmental Action, Navy (CLEAN) Contract No. N62467-89-D-0317, Contract Task Order No. 041. The majority of field activities associated with the Interim Corrective Measure Screening Investigation were completed in October and November 1992. During January and March 1993, additional field activities were conducted to complete the investigation. These activities included collection of groundwater samples from 11 private irrigation wells (PIWs) (January) and collection of groundwater samples from within and north of the landfill (March). Results of the additional activities are reported in the Interim Corrective Measure Investigation Addendum, which is included in this report as Section 8.0. The following subsections describe the site, the objectives of the investigation, and the regulatory setting.

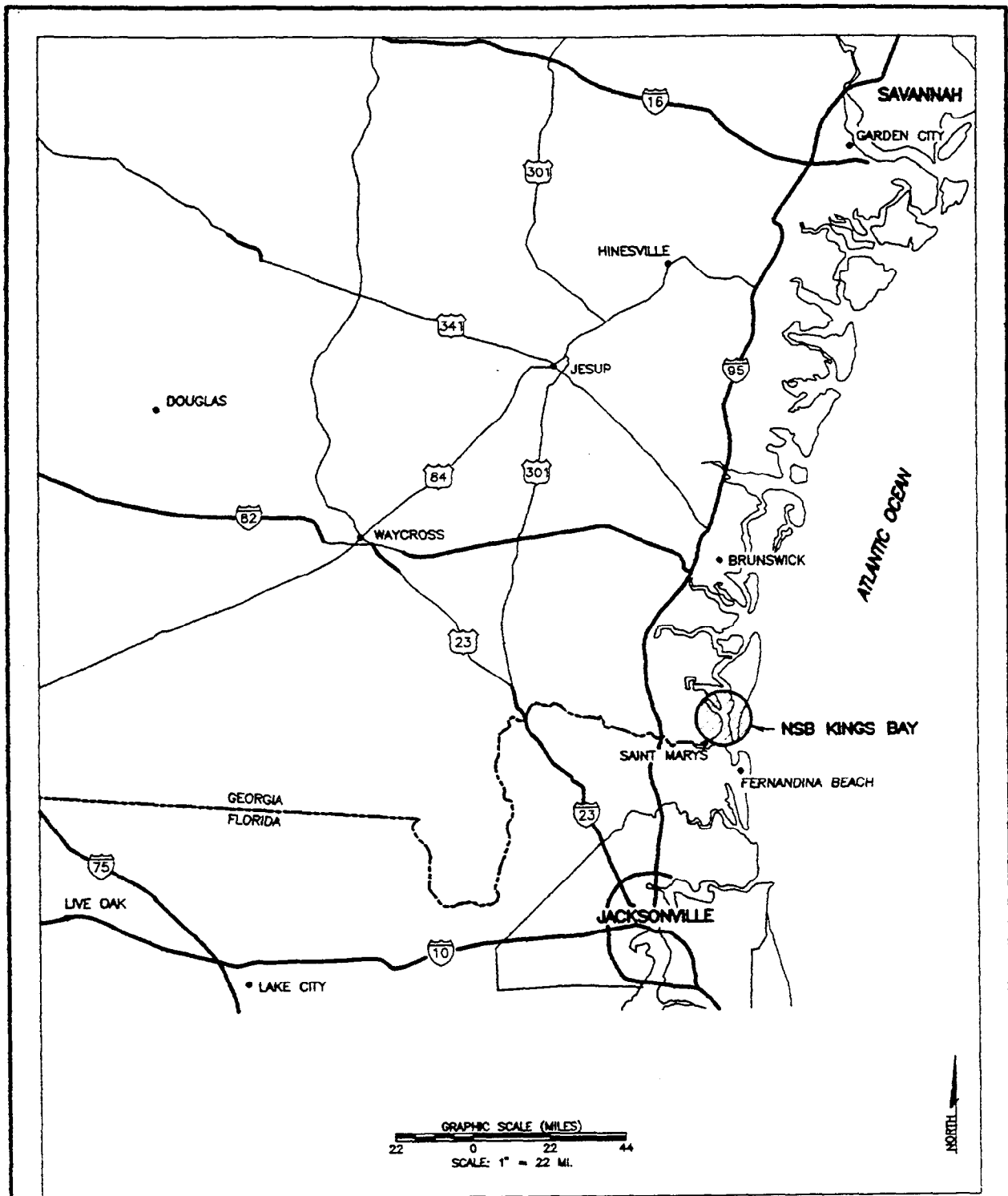
### 1.1 SITE DESCRIPTION AND HYDROGEOLOGIC SETTING.


1.1.1 Site Description The NSB Kings Bay is located in Camden County in southeastern Georgia, approximately 6 miles north of the Florida-Georgia State line. Kings Bay is an arm of the Cumberland Sound, which is connected to the Atlantic Ocean via the St. Marys Inlet. Figure 1-1 shows the general location of the NSB Kings Bay. The NSB is included on the Harriett's Bluff topographic quadrangle map (Figure 1-2).

Most of the land near the NSB is rural. Only 8 percent of the land in the county is developed. Most development has occurred in the cities of St. Marys, Woodbine, and Kingsland. The developed land consists mostly of light residential with some commercial areas. Camden County's potential for residential or industrial development is reduced by poor soil drainage properties caused by shallow groundwater. Undeveloped land consists of forests, marshes, and swamps (ABB-ES, 1992a). Site 11 is one of three former disposal areas currently being investigated. A fourth disposal area, Site 12, was reportedly remediated during construction of a dry dock. Site locations are shown in Figure 1-3.

Wetlands comprise more than one-third of Camden County's total acreage. Site 11, the Old Camden County Landfill, is located in the western portion of the NSB Kings Bay, as shown on Figure 1-3. The landfill occupies approximately 35 acres situated along the northwest boundary of the NSB. The landfill was operated by Camden County from 1974 to 1981 and reportedly received no hazardous waste. Approximately 500,000 cubic yards of waste were disposed at the landfill and reportedly consisted of general household, office waste, scrap paper and wood, and wastes (sludge and grit) from the NSB sewage treatment plant. Burning of wastes before burial was allowed during the first year the landfill operated; however, this practice was disallowed after 1975. It is not known if fuel was used to ignite wastes that were burned.

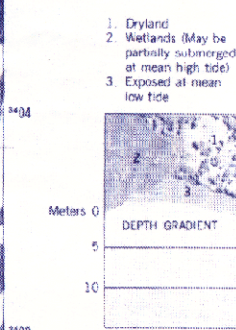
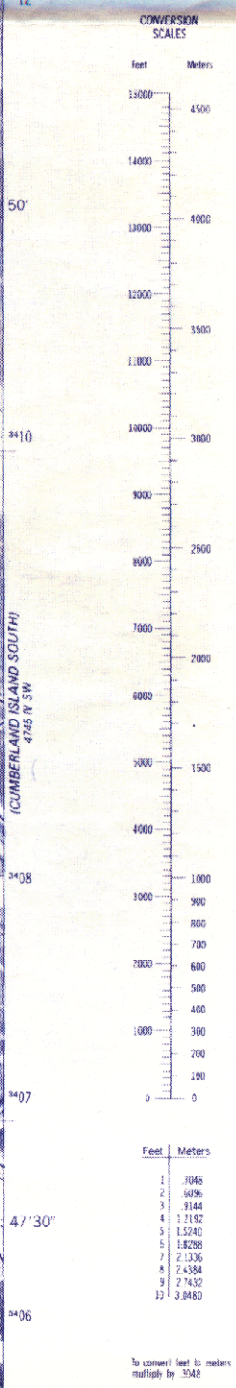
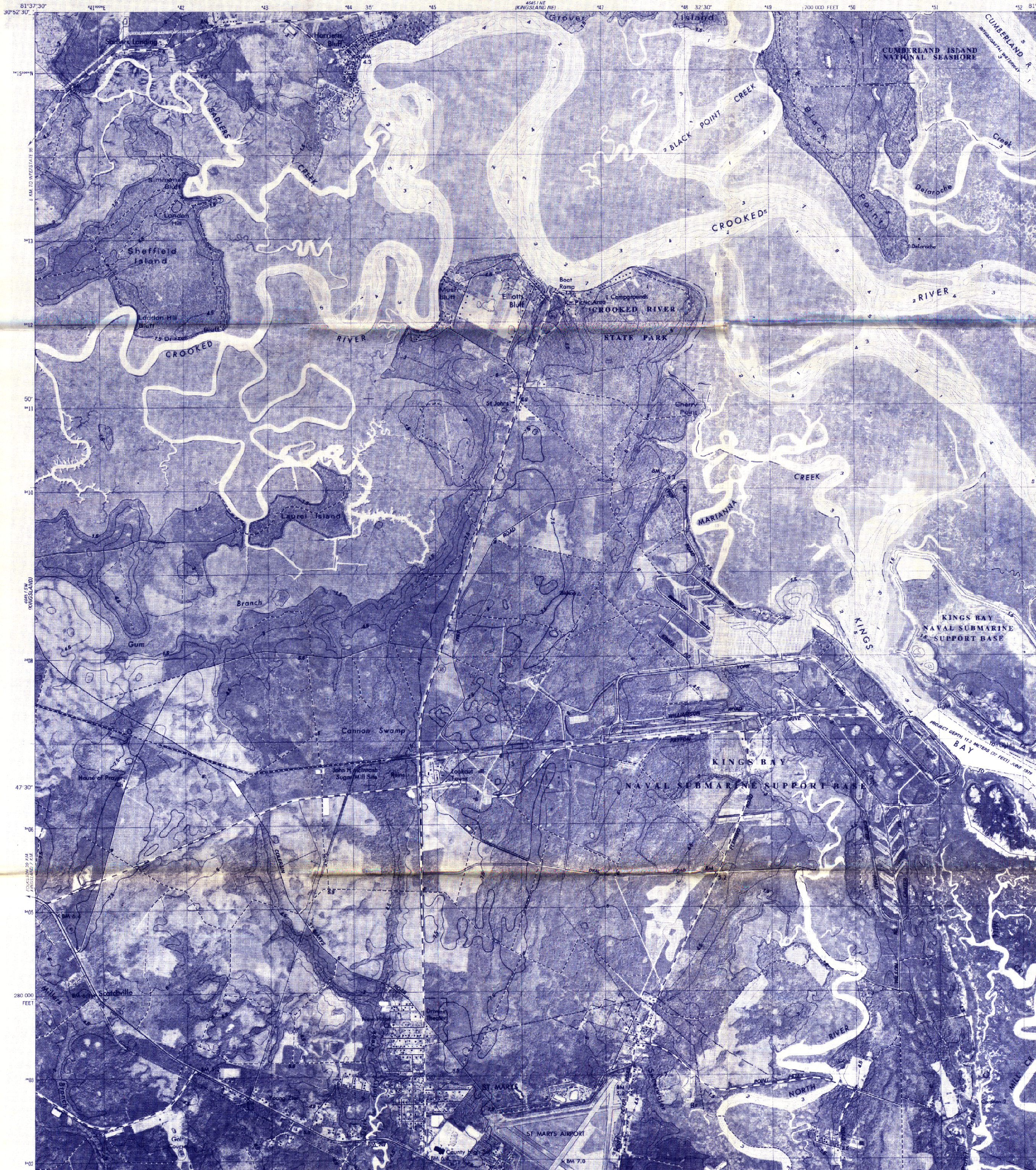
The landfill operated as a trench-and-fill operation with trenches oriented in a southeast to northwest direction. The trenches were reportedly 575 to 775 feet long, 20 feet wide, and approximately 8 feet below ground surface (bgs). The



DWN: DMF	DES: DMF	PROJECT NO.: 7553	TITLE:  REGIONAL LOCATION MAP	
CHKD: KMH	APPD.: LBH	FIGURE NO.: 1-1		
DATE: 8-3-93	REV.:			

INTERIM CORRECTIVE MEASURE SORTING  
INVESTIGATION REPORT  
NAVAL SUBMARINE BASE, KINGS BAY, GEORGIA

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Produced by the United States Geological Survey and the National Ocean Service  
Control by USGS, NOS/NOAA, and USCE  
Orthophotomaps prepared by the Geological Survey from aerial photographs taken April 19, 1974. Topography by planimetric surveys 1958; revised from aerial photographs taken 1974. Field checked 1975. Map edited 1980.  
Bathymetry compiled by the National Ocean Service from tide-coordinated hydrographic survey.  
Soundings compiled from NOS 11503 and 11504.  
This information is not intended for navigational purposes.  
Mean lower low water (dotted) line and mean high water (solid) line compiled by NOS from tide-coordinated aerial photographs.  
Apparent shoreline (outer edge of vegetation) shown by photomaps.  
Projection and 10,000 foot grid ticks. Georgia coordinate system, east zone (transverse Mercator).  
1000-meter Universal Transverse Mercator grid, zone 17.  
1927 North American Datum.  
To place on the predicted North American Datum 1983, move the projection lines 21 meters south and 17 meters west as shown by dashed corner ticks.  
There may be private inholdings within the boundaries of the National or State reservations shown on this map.

UTM GRID AND 1000 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

QUADRANGLE LOCATION

CONTOURS AND ELEVATIONS IN METERS

Survey Number	Survey Date	Survey Scale	Survey Line Spacing (Meters)
H-5753	1935	1:10,000	03-12
H-5754	1934-35	1:10,000	03-08
H-5756	1965	1:10,000	03-10
H-5805	1979	1:2,500	01-02

HYDROGRAPHIC SURVEY INFORMATION

BASE MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS  
BATHYMETRIC SURVEY DATA COMPLIES WITH INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) SPECIAL PUBLICATION 44 ACCURACY STANDARDS  
INDICATOR STANDARDS USED AT THE DATE OF THE SURVEY  
AND NATIONAL OCEAN SERVICE, ROCKVILLE, MARYLAND 20852  
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

SCALE 1:24,000

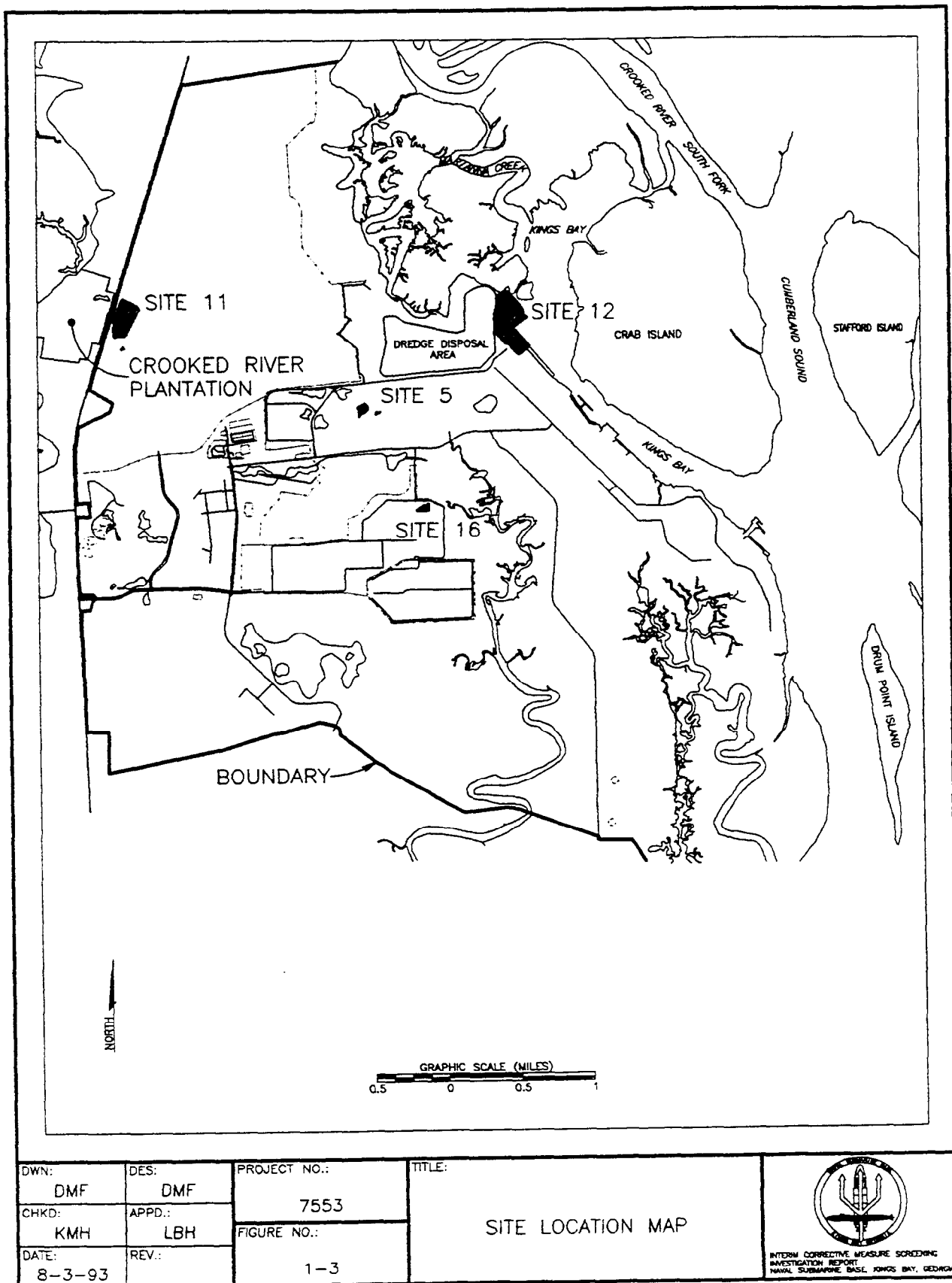
CONTOUR INTERVAL 1.5 METERS  
NATIONAL GEODETIC VERTICAL DATUM OF 1929  
BATHYMETRIC CONTOUR INTERVAL 1 METER WITH SUPPLEMENTARY 0.5 METER CONTOURS - SOUNDINGS IN METERS  
DATUM IS MEAN LOWER LOW WATER  
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE

ROAD CLASSIFICATION

Primary highway, hard surface  
Secondary highway, hard surface  
Light duty road, hard or improved surface  
Unimproved road  
Trails  
Interstate Route  
U.S. Route  
State Route

HARRIETTS BLUFF, GA.  
30081-65-0M-024  
1980  
PHOTOREVISED 1982  
DMA 4615186 SERIES V8480

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landfill ceased operations in October 1981 and was covered with 2 feet of fill. The landfill surface is currently vegetated with grasses, weeds, and pine saplings.

The Crooked River Plantation Subdivision is a residential development of 630 homes west of the landfill. The subdivision was built on 260 acres west of Spur 40 during the 1980s. A marsh fronts the north and west perimeter of the subdivision. An informal survey of the Crooked River Plantation Subdivision residents was performed to obtain information regarding private irrigation wells (PIWs). Based on the survey response of the residents, more than 90 homes in the subdivision have PIWs that draw groundwater from the surficial aquifer for non-potable uses such as lawn irrigation and washing outdoor items.

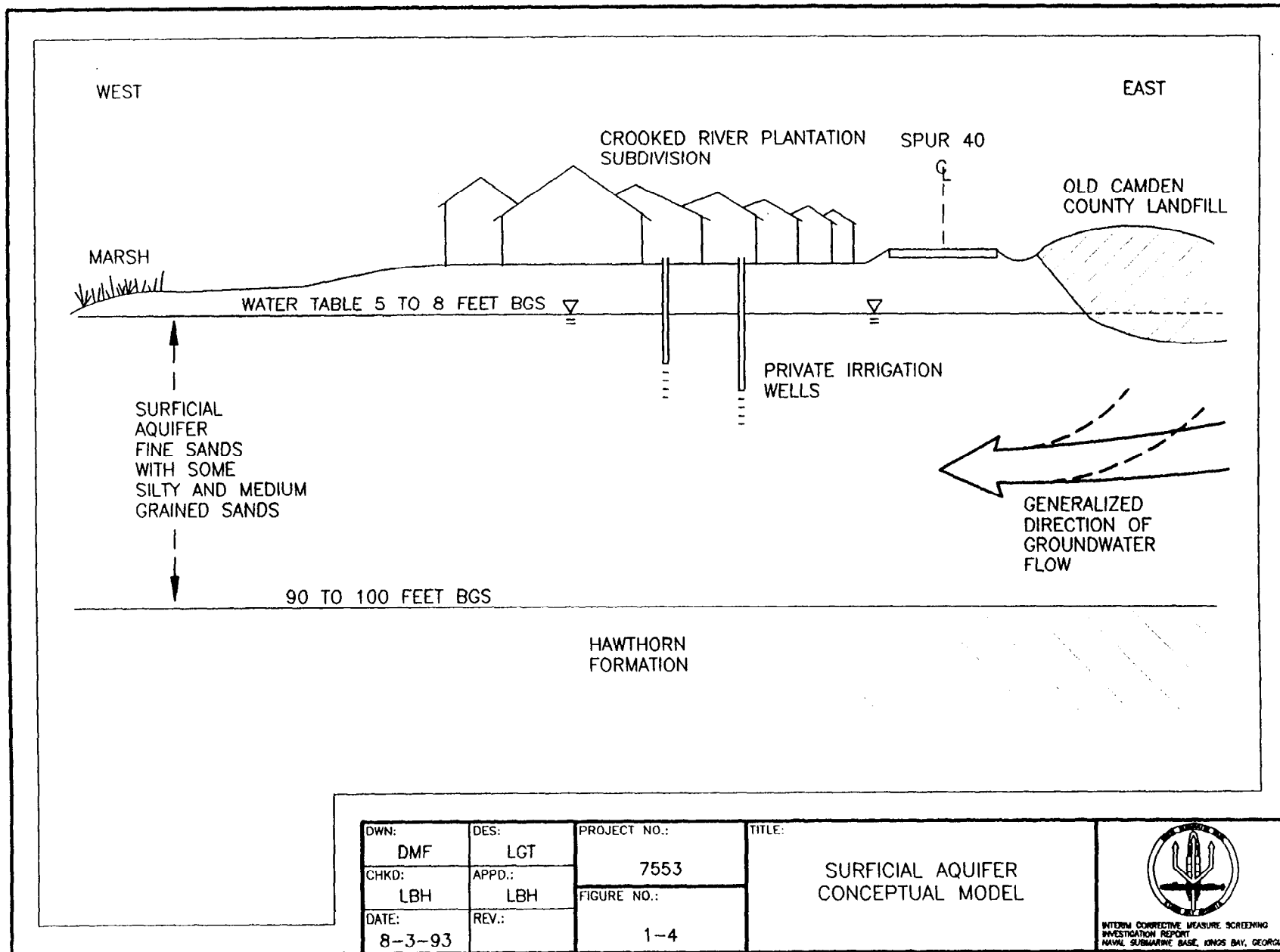
1.1.2 Hydrogeologic Setting A conceptual model of the hydrogeologic setting is discussed below. This model describes the generalized physical conditions of the site that affect contaminant migration.

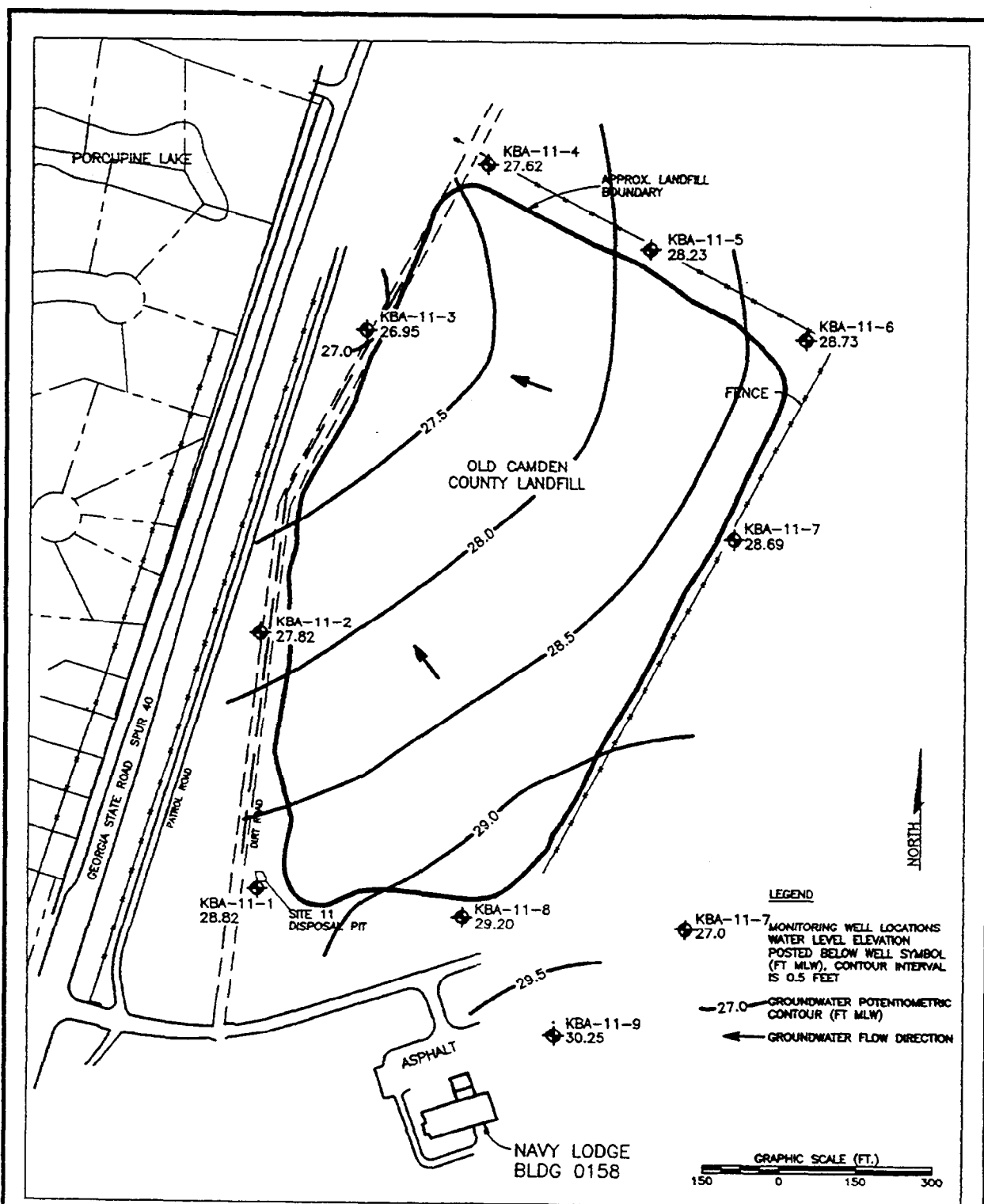
The average elevation of the landfill surface and surrounding area is approximately 30 to 40 feet above mean low water (MLW) and is characterized by relatively flat to gently sloping surface topography. Surface runoff infiltrates into the permeable sands of the surficial aquifer. The surficial aquifer is a relatively homogeneous, water table aquifer and consists mainly of fine-grained sands with some silty sands and medium-grained sands, as shown in Figure 1-4. The water table is approximately 5 to 8 feet bgs. The aquifer thickness is approximately 90 feet in the vicinity of the landfill. The overall hydraulic gradient in the vicinity of the landfill slopes gently towards the west-northwest, as shown in Figure 1-5. In general, groundwater flows laterally in this direction and ultimately discharges to surface water. Some localized variations in groundwater flow exist, such as localized mounding in the area of monitoring well KBA-11-8 (Figure 1-5). The base of the surficial aquifer is the Cooper Marl. This marl is an approximately 200-foot-thick confining layer consisting of clays and limestones.

The primary potable source aquifer in the vicinity of the landfill, part of the Floridan aquifer system, is between 470 to 570 feet bgs. It is separated from the surficial aquifer by the Hawthorn Formation and a secondary confined aquifer.

1.2 PREVIOUS INVESTIGATIONS. Site 11, the Old Camden County Landfill, was first investigated in 1985 when an Initial Assessment Study was performed at NSB Kings Bay (C.C. Johnson, 1985). The Initial Assessment Study consisted of records searches and interviews. Sixteen sites were evaluated and none were recommended for further investigation. However, four sites, including the Old Camden County Landfill, required further action under the Hazardous and Solid Waste Amendments (HSWA) permit issued to NSB Kings Bay by the Georgia Department of Natural Resources (GA DNR). A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan was prepared (ABB-ES, 1991). The work plan set forth the methodology for investigation of Sites 5, 11, and 16. No investigation activities were planned for Site 12.

The RFI Work Plan was implemented in January 1992. The RFI included geophysical surveys, subsurface soil sampling, and the installation of nine groundwater monitoring wells around the perimeter of the landfill. Part of the RFI included six bimonthly groundwater monitoring events. The sixth monitoring event was completed in January 1993. Results of the first three groundwater monitoring





OWN:	DES:	PROJECT NO.:	TITLE:
DMF	NLW	7553	GROUNDWATER POTENTIOMETRIC
CHKD:	APPD:	FIGURE NO.:	SURFACE MAP
LBH	LBH	1-5	NOVEMBER 10, 1992
DATE:	REV.:		
8-3-93			



INTERIM CORRECTIVE MEASURE SCREENING  
INVESTIGATION REPORT  
NAVAL SUBMARINE BASE, KINGS BAY, GEORGIA

events at Site 11 indicated concentrations of vinyl chloride ranging from 18 to 150 micrograms per liter ( $\mu\text{g/l}$ ) in samples from monitoring well KBA-11-2, located on the western edge of the landfill. In August 1992, a Phase I Interim Investigation was conducted to begin characterization of volatile organic compounds (VOCs) in groundwater. Results of this investigation are presented in the Phase I Interim Investigation Report (ABB-ES, 1992b) and are summarized in the following paragraphs.

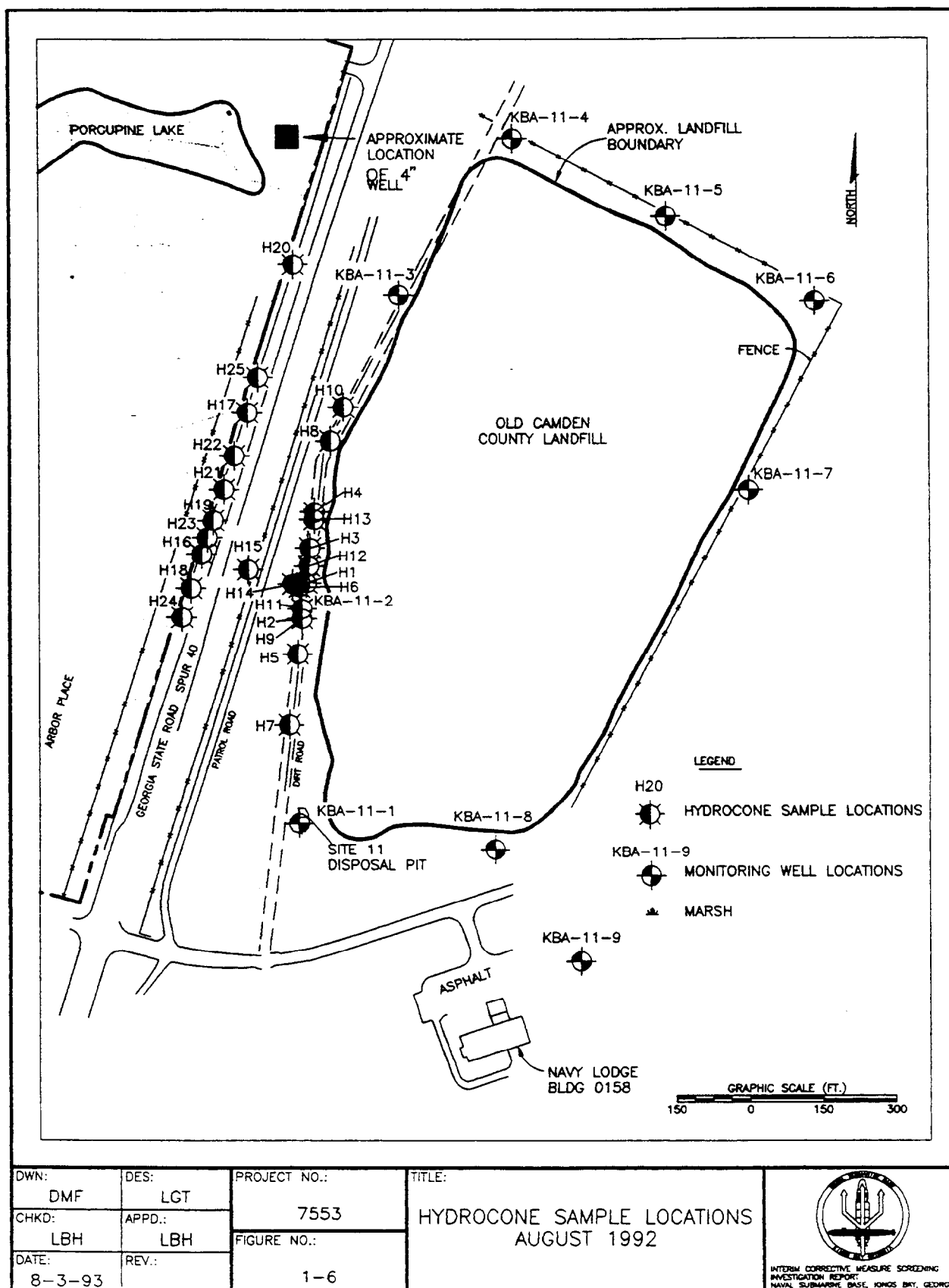
The Phase I Interim Investigation included collection of groundwater samples using direct push technology. Thirty-six groundwater samples were collected from 25 locations downgradient of the landfill (Figure 1-6). The groundwater samples were analyzed in an on-site laboratory for VOCs, including vinyl chloride, chloromethane, trans-1,2-dichloroethene, trichloroethene, and tetrachloroethene. Duplicate groundwater samples were also sent to an off-site analytical laboratory for confirmation.

The results of this investigation confirmed that at least 18 VOCs had migrated, via the groundwater, beyond the boundary of the landfill and as far as the western right-of-way of Spur 40, which is adjacent to Crooked River Plantation Subdivision. These chemicals included solvent-related VOCs such as dichloroethene and vinyl chloride as well as fuel-related VOCs such as benzene, ethylbenzene, toluene, and xylenes.

**1.3 REGULATORY SETTING.** In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, and the Superfund Amendments and Reauthorization Act (SARA) of 1986, the Department of Defense (DOD) conducts an Installation Restoration (IR) program for evaluation and remediation of problems related to the release and disposal of hazardous materials at DOD facilities. The IR program was established to identify the presence of suspected contamination at Navy and Marine Corps facilities from past operations and, if needed, to institute corrective remedial measures. The IR Program is conducted in four phases: Phase I, Preliminary Assessment/Site Investigation; Phase II, Remedial Investigation/Feasibility Study (RI/FS); Phase III, Remedial Design/Remedial Action; and Phase IV, Site Closure (SC).

Under CERCLA, the Hazard Ranking System (HRS) is used to prioritize hazardous waste sites and list them for cleanup activities on the U.S. Environmental Protection Agency's (USEPA's) National Priorities List (NPL) (USEPA, 1990a). The Navy is required to evaluate formerly used defense sites as well as currently operating facilities. Under SARA, Congress established the Federal Agency Hazardous Waste Compliance Docket, also known as the Federal Facility Docket. The purpose of the docket is to identify Federal facilities that potentially could be included on the NPL and compile and maintain information on the cleanup status of these sites. The Navy has used the latest HRS (II) to rank NSB Kings Bay. The overall facility score was 47.59 (ABB-ES, 1992a). This score is a composite of the three sites under study at NSB Kings Bay, and indicates that NSB Kings Bay could be listed on the NPL in the future. USEPA has not confirmed this score.

In 1976, Congress passed RCRA to govern facilities where current operational practices involve the generation, handling, or disposal of hazardous substances. RCRA was amended in 1984 with the passage of the HSWA. Under these amendments, corrective action is required for the release of hazardous waste from solid waste management units (SWMUs) at hazardous waste treatment, storage, or disposal facilities (USEPA, 1990b). The RCRA Corrective Action Program uses a four-phase



approach to evaluate the condition of SWMUs and direct corrective action, if necessary, at these sites.

The first phase, a RCRA Facility Assessment (RFA), was not formally conducted at NSB Kings Bay by representatives of the State and Federal regulatory agencies. However, the GA DNR issued an HSWA Permit to NSB on September 29, 1989. The HSWA permit identified four SWMUs that were suspected to be sources of current or past releases of hazardous substances to the environment. NSB was directed to develop an RFI work plan and conduct an RFI to verify the release of toxic or hazardous substances and obtain information on the nature and extent of the contamination. Information collected during the RFI phase will be used to determine whether there is a need for interim corrective measures and will also aid in the development and implementation of appropriate corrective measures. The fourth phase, a Corrective Measure Study (CMS) will be prescribed if the release is characterized in the RFI as either immediately or potentially threatening to human health or the environment.

Because NSB Kings Bay is operating under a current RCRA permit, the facility is obligated to follow RCRA regulations. Activities conducted to investigate and remediate releases from Site 11 may be evaluated against CERCLA criteria if the USEPA lists NSB Kings Bay on the NPL. This Interim Corrective Measure Screening Investigation was designed to address both RCRA and CERCLA regulations.

1.4 OBJECTIVES OF THE INTERIM CORRECTIVE MEASURE SCREENING INVESTIGATION. This investigation was initiated to establish whether the VOCs detected in groundwater downgradient of Site 11 as part of the overall RFI field program at NSB Kings Bay have migrated into the Crooked River Plantation Subdivision. Previous investigations at the landfill confirmed that VOCs have migrated off site toward the subdivision. An Interim Corrective Measure Screening Investigation was planned to establish whether an immediate threat to human health exists within the subdivision. This report documents the findings of the Interim Corrective Measure Screening Investigation, including a screening risk evaluation. A more complete risk assessment will be done as part of the ongoing RFI.

The objectives of the field sampling program were to provide sufficient information to evaluate the following:

- the horizontal and vertical extent of groundwater contamination,
- contaminants of potential concern in the surficial aquifer and their concentrations,
- contaminants of potential concern, if any, in the PIW water samples collected within the Crooked River Plantation Subdivision,
- possible contamination of surface water and sediment in Porcupine Lake,
- presence of potential contaminants in the vadose zone, and
- potential human health risks associated with the use of PIW water or recreational use of Porcupine Lake.

The data provided during this investigation will be used to develop the Supplemental RFI Work Plan and the Interim Measure Work Plan.

1.5 REPORT ORGANIZATION. This report presents conclusions and recommendations based on analysis and evaluation of data collected during the Interim Corrective Measure Screening Investigation at the Old Camden County Landfill and includes the following:

- Introduction includes the objectives of the investigation, site description, regulatory setting, and report organization;
- Site Investigation Program discusses the site-specific field program and activities;
- Analytical Program discusses the analytical program, and data quality and use;
- Results of the Investigation discusses the chemical and hydrogeologic data in relation to interpreting the site's physical conditions;
- Applicable or Relevant and Appropriate Requirements (ARARs) and Media Protection Standards discusses the chemical data compared to state and federal regulations and criteria for protection of human health and the environment;
- Screening Human Health Risk Evaluation discusses the human health risks associated with exposure to the chemicals identified in groundwater within the surficial aquifer; and
- Summary and Recommendations summarizes the results of the Interim Corrective Measures Screening Investigation in support of recommendations for a confirmatory investigation and CMS.
- Corrective Measure Screening Investigation Addendum describes the field program, analytical program, and results of additional activities conducted as part of the Interim Corrective Measure Screening Investigation.

## 2.0 SITE INVESTIGATION PROGRAM

The following subsections describe the scope and components of the Interim Corrective Measure Screening Investigation field program at the Old Camden County Landfill. Included are discussions of methods used to collect samples of groundwater, surface water, sediment, and soil vapor. An air screening survey and records search were performed and stratigraphic information was also collected.

2.1 RECORDS SEARCH. A records search conducted from October 12 through 15, 1992, evaluated past use of land near the Old Camden County Landfill. The search covered approximately 6,000 acres west of Spur 40 in the area of the landfill. Records were examined in the offices of the Camden County tax assessor, registrar, and the planning commission.

2.2 SAMPLE IDENTIFICATION. During the Interim Corrective Measure Screening Investigation, location identifiers were consecutive beginning with location 101. During the Phase I Interim Investigation, location identifiers were consecutive beginning with location 1.

Sample identification for groundwater samples collected using the hydrocone includes location and depth information, as described below:

H      101    25

H = hydrocone

101 = location identifier

25 = upper limit of 1-foot sample interval in feet bgs

Piezocone and vapor cone locations are identified by P (piezocone) or V (vapor cone) followed by a numeric location identifier. Piezocone, hydrocone, and vapor cone samplers are discussed in Section 2.3 of this report. Sediment and surface water samples are similarly identified by SD (sediment) or SW (surface water) followed by a location identifier. PIW samples were labeled consecutively starting with location one, preceded by CRP-PW, which signifies a PIW in the Crooked River Plantation Subdivision.

The analytical program for the investigation included on-site laboratory analyses for 10 target VOCs using two gas chromatographs equipped for purge-and-trap. Target VOCs included:

vinyl chloride  
cis-1,2-dichloroethene  
trans-1,2-dichloroethene  
trichloroethene  
tetrachloroethene  
benzene  
toluene  
m/p-xylene  
o-xylene  
ethylbenzene

A minimum of 10 percent groundwater and PIW samples, and all sediment and surface water samples, were submitted to an off-site laboratory for analysis of VOCs using Contract Laboratory Program (CLP) methods. Sediment, surface water, and three groundwater samples were also analyzed for semivolatile organic compounds (SVOCs).

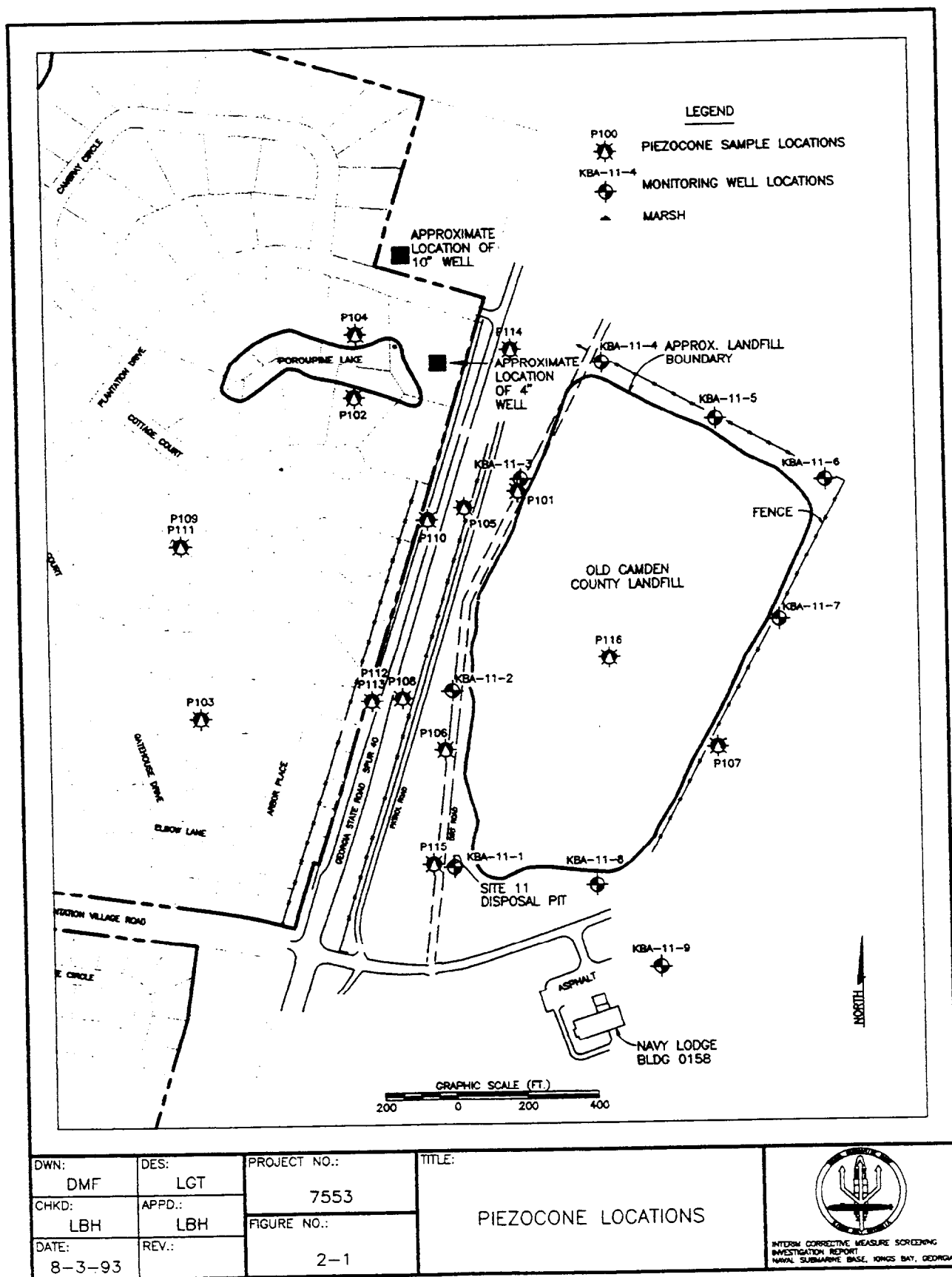
**2.3 DIRECT PUSH TECHNOLOGY FIELD PROGRAM.** The stratigraphy and the distribution of VOC contaminants within the surficial sand aquifer were evaluated using direct push methods provided under subcontract. The equipment consisted of a cone penetrometer truck, piezocone, hydrocone groundwater sampler, soil vapor sampler, and a computer and associated software. This equipment was used to collect:

- information regarding subsurface material characteristics based on piezocone measurements;
- collect groundwater samples and hydraulic conductivity measurements from the aquifer; and
- soil gas samples.

**2.3.1 Stratigraphic Investigation** Piezocone penetrations are made by hydraulically advancing a series of steel rods into the soil at a constant rate. Resistance to penetration at the cone tip and at the outer surface of the sleeve, located near the cone tip, is recorded. Subsurface pore pressure is monitored with a pressure transducer. These measurements are recorded by the on-board computer. The data are compared to empirically derived measurements or parameters characteristic of different soil types. The piezocone is able to provide information regarding soil classifications consistent with the Unified Soil Classification System, relative soil density (split-spoon blow counts), water levels, and effective thickness of confining units, if any.

Stratigraphic information was obtained from 15 locations at the landfill, west of Spur 40, and in the Crooked River Plantation Subdivision. Location P115 was attempted, but the piezocone could not extend beyond the polyvinyl chloride (PVC) casing because of sand that flowed into the casing. Figure 2-1 shows the locations where piezocone penetrations were made. Piezocone penetrations were conducted at select locations in conjunction with hydrocone groundwater sampling. The observations of this investigative effort are discussed in Subsection 4.2 of this report.

**2.3.2 Hydrocone Groundwater Sampling and Permeability Measurements** The hydrocone groundwater sampler consisted of a telescoping assembly containing a 1-foot length of stainless-steel well screen fitted with a cone tip. This assemblage was hydraulically advanced with a series of rods in the same manner as the piezocone penetrations. When the screen was exposed by retracting the outer casing of the sample device, natural hydrostatic pressure forced groundwater to flow into the sample collection chamber. The amount of groundwater entering the collection chamber was monitored and controlled by pressuring the collection chamber with argon gas. Argon back-pressure prevented volatilization of the sample during collection and retrieval. The sample was held in the chamber for retrieval by using argon gas back-pressure to impinge a small ball into its



check-valve at the bottom of the sample collection chamber. The sample collection chamber and screen assemblage were lifted to the surface to recover the sample. To collect water from multiple intervals, the hole was reentered with a clean sample collection chamber and screen assemblage and the hydrocone was advanced to the desired depth. Cross-contamination was prevented by using O-rings to form water-tight seals above and below the sample chamber. The pressure transducer and computer monitored the sample chamber for infiltration of water.

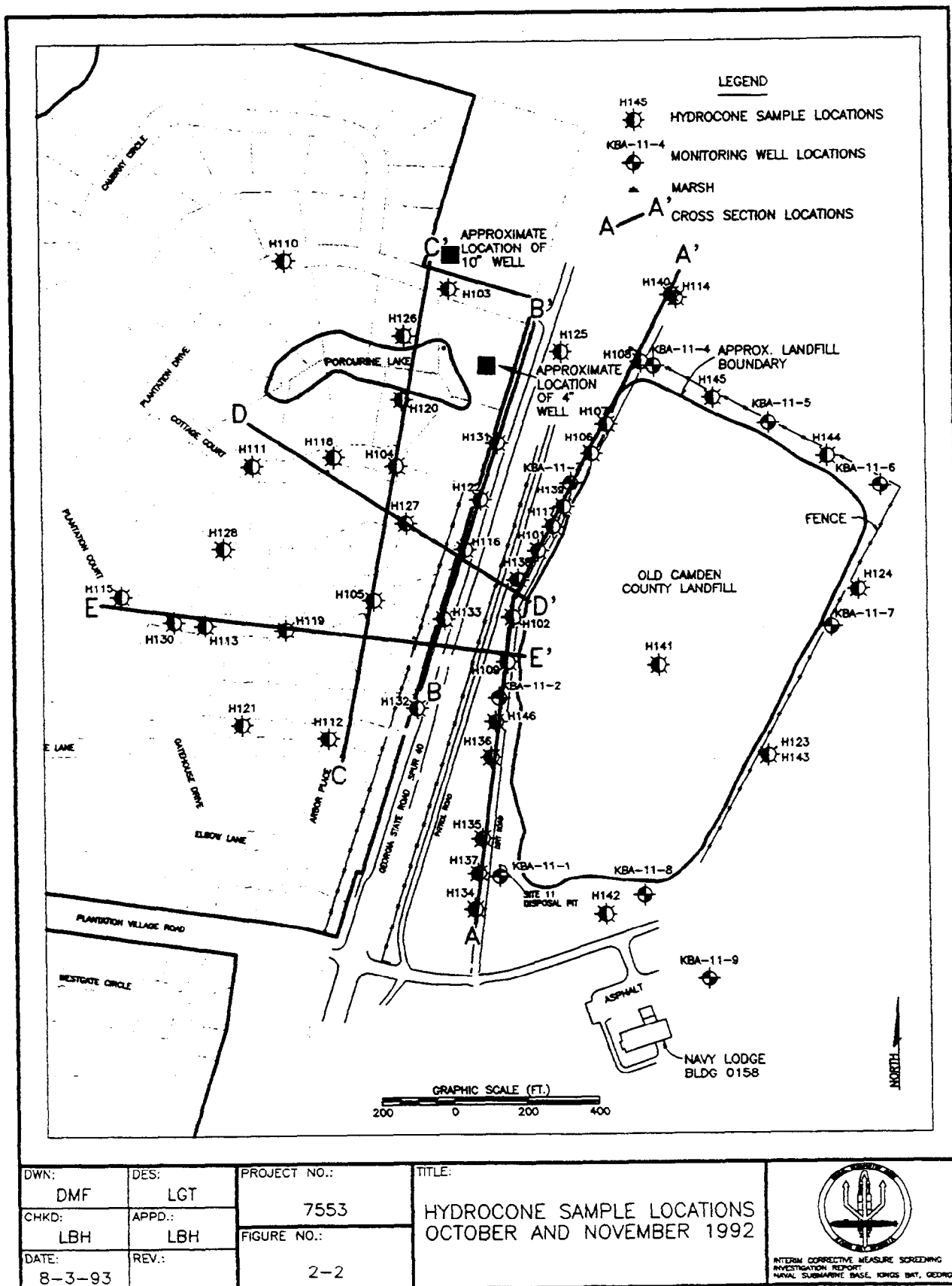
During sample collection, the rate of filling the 6.5-foot-long cylinder was recorded. These data were plotted with the computer to estimate permeability at specific intervals within the aquifer. The analysis was performed using Hvorslev's Basic Time Lag Method. The results are presented in Appendix E and discussed in Section 4.2.

Over a 5-week period from October 14 to November 18, 1992, groundwater samples were collected from 46 locations in the area of the landfill, on the western right-of-way of Spur 40, and in the Crooked River Plantation Subdivision (see Figure 2-2). One of the 46 locations was inside the landfill boundaries. Additional groundwater sampling activities are planned for March 1993. These additional sample locations will be inside the landfill and to the north of the landfill.

A total of 144 groundwater samples were collected from depths ranging from 5 to 72 feet bgs. Sample locations and depth intervals were chosen based on analytical data provided by the on-site laboratory. Thus, the location and depth interval of successive samples were selected based on analytical information from preceding samples. Sampling objectives included evaluating the horizontal and vertical extent of VOC contamination and characterizing concentrations of VOCs in the plume.

All groundwater samples collected with the hydrocone were analyzed for target VOCs in the on-site laboratory. Seventeen hydrocone groundwater samples were submitted to an off-site laboratory for confirmatory analysis. Off-site analysis included Target Compound List (TCL) VOCs using the USEPA CLP Statement of Work (SOW) for multi-media samples (USEPA, 1991a). Section 3.0 provides more detailed information about the analytical program for this investigation. The results of this sampling effort are discussed in Subsections 4.6 and 4.7 of this report.

**2.3.3 Soil Vapor Sampling** Soil gas samples were collected from the unsaturated zone using direct push methods and a vapor cone sampler. The vapor cone sampler was constructed of 1.5-inch-diameter alloy steel. The sampler was pushed to an approximate depth of 3.5 feet bgs (6 inches above the water table) using hydraulic pressure from the rig, and then the outer casing was retracted, exposing the sampler tip. Soil gas entered ports in the sampler tip and were conveyed to Tedlar bags through tygon tubing. An AeroVironment™ Pulse Pump III, a positive displacement, dry piston pump, was used to draw the required volume of sample. The pump was purged with argon gas between samples. New tygon tubing and decontaminated vapor cones were used to collect each sample. Tedlar bags were reused after being purged with three volumes of argon gas and analyses of blank samples indicated the bags did not contain detectable concentrations of target VOCs.



Vapor cone soil gas samples were collected from a total of 22 locations. Eighteen locations were within the landfill boundaries in areas between disposal trenches based on evaluation of site topography. Four locations were around monitoring well KBA-11-2. This sampling was conducted on November 1 and 2, 1992. Figure 2-3 shows locations where soil gas samples were collected. Soil gas samples were analyzed in the on-site laboratory; none were submitted for off-site analysis. Data for the soil gas samples were used to evaluate the potential for migration of VOCs from groundwater into the soil. The results of this sampling effort are discussed in Subsection 4.5 of this report.

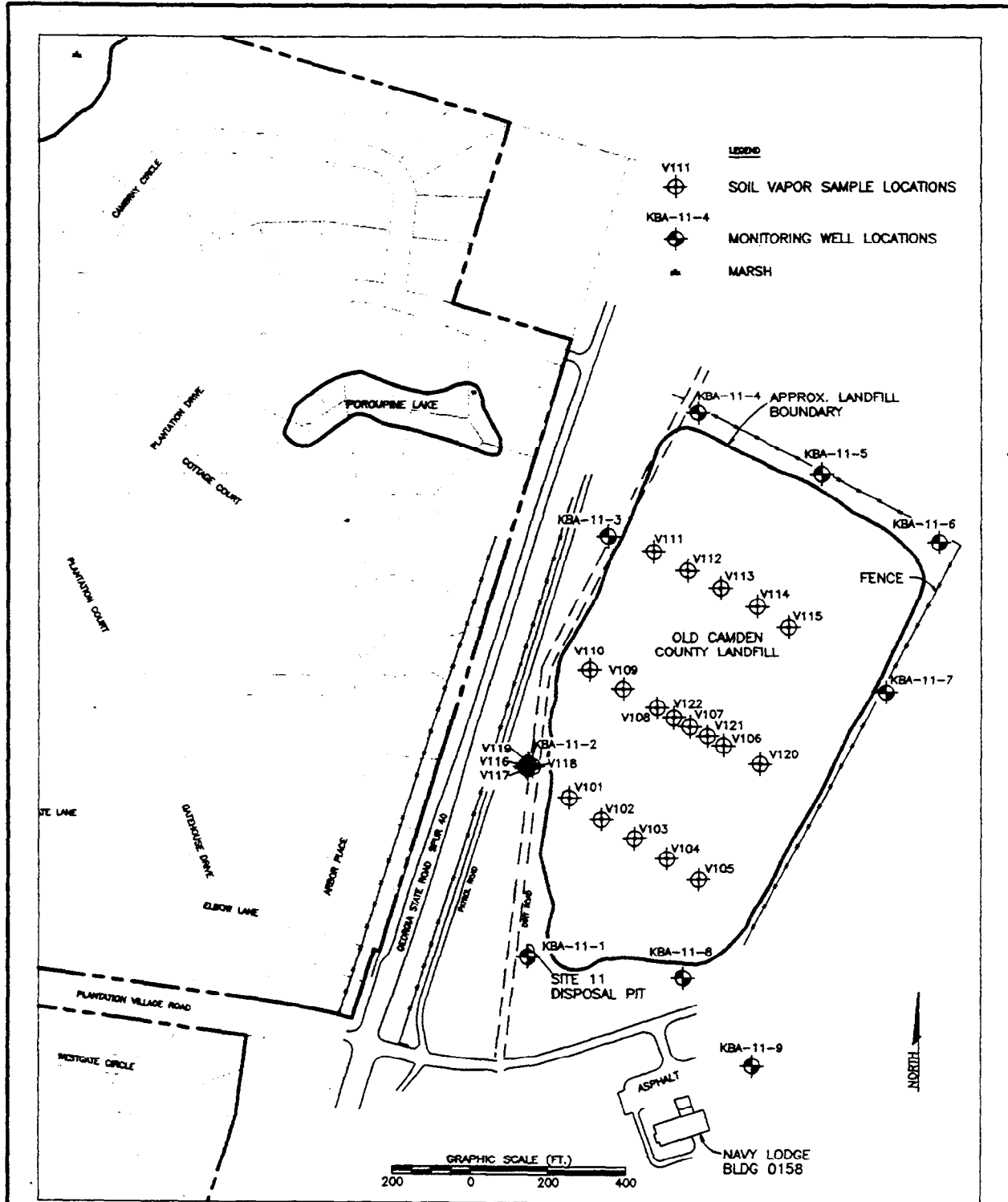
**2.3.4 Difficulties Encountered During Penetration Tests** The direct push equipment had difficulty penetrating a dense fine-grained sand layer present at depths of 9 to 20 feet bgs around and beneath the landfill. From November 11 through 15, 1992, hollow-stem auger drilling services were employed to set 2-inch inside diameter, Schedule 40, PVC casings to depths of approximately 20 feet bgs. Direct push instrumentation was advanced through the casings at 12 locations, including one piezocone location and 11 hydrocone locations. Locations where penetrations were conducted using PVC surface casing included:

P115	H139
H134	H140
H135	H141
H136	H142
H137	H143
H138	H144

These locations are included on Figure 2-2. At each location, two or three casings were set approximately 5 feet apart. The subsequent samples are considered to be from one location. The direct push instruments could only be advanced through the PVC casings once. Attempts to reenter holes resulted in broken equipment, namely rods. Using multiple casings at each location allowed samples to be collected from various depths at each location.

**2.4 PRIVATE IRRIGATION WELL SAMPLING.** On two occasions, residents of the Crooked River Plantation Subdivision were provided questionnaires requesting information about PIWs. The results of the initial questionnaire and information obtained during a public meeting on September 3, 1992, identified 94 PIWs. The second questionnaire requested permission to collect groundwater samples from PIWs and asked property owners for physical information about their PIWs and specifics of use. Copies of forms used in preparation for and during the Interim Corrective Measure Screening Investigation are included in Appendix A. Appendix B contains copies of completed questionnaires and consent forms that contain specific information about particular PIWs. A summary table is included at the end of Appendix B. This summary table includes sample and analysis information.

Groundwater samples were collected from 51 PIWs in the Crooked River Plantation Subdivision from October 28 through November 4, 1992. Figure 2-4 shows the locations where PIW samples were collected. All samples were analyzed for target VOCs in the on-site laboratory. Twenty-four PIW samples were submitted to the off-site laboratory for confirmatory analysis using the CLP SOW for multi-media samples (USEPA, 1991a). Before sampling of PIWs began, the horizontal extent of the plume was delineated using data from on-site analysis of hydrocone groundwater samples. Based on this delineation, all PIW samples collected from



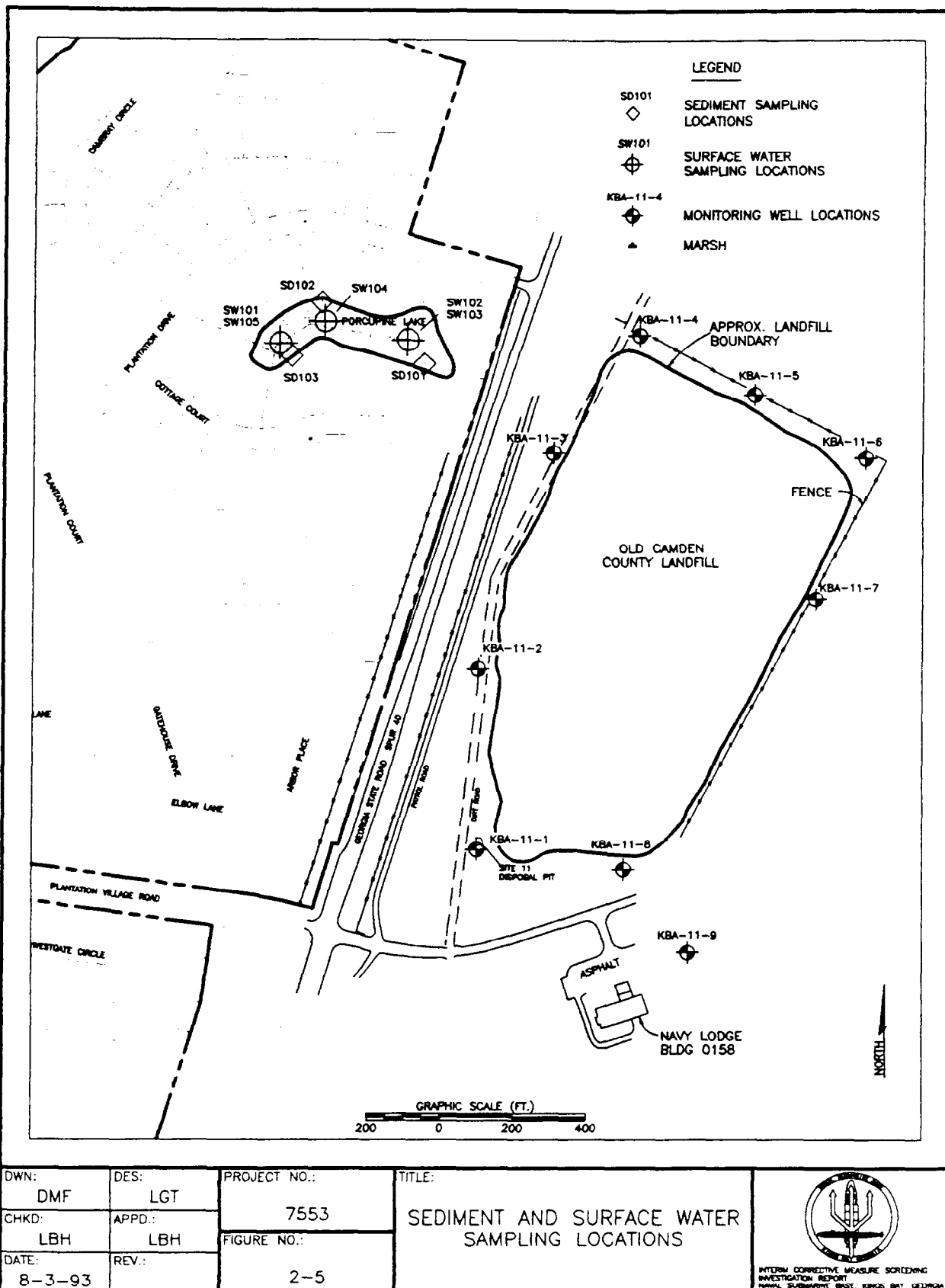
DWN: DMF	DES: LGT	PROJECT NO.: 7553	TITLE: VAPOR CONE SAMPLE LOCATIONS	
CHKD: LBH	APPD.: LBH	FIGURE NO.: 2-3		
DATE: 8-3-93	REV.: 			

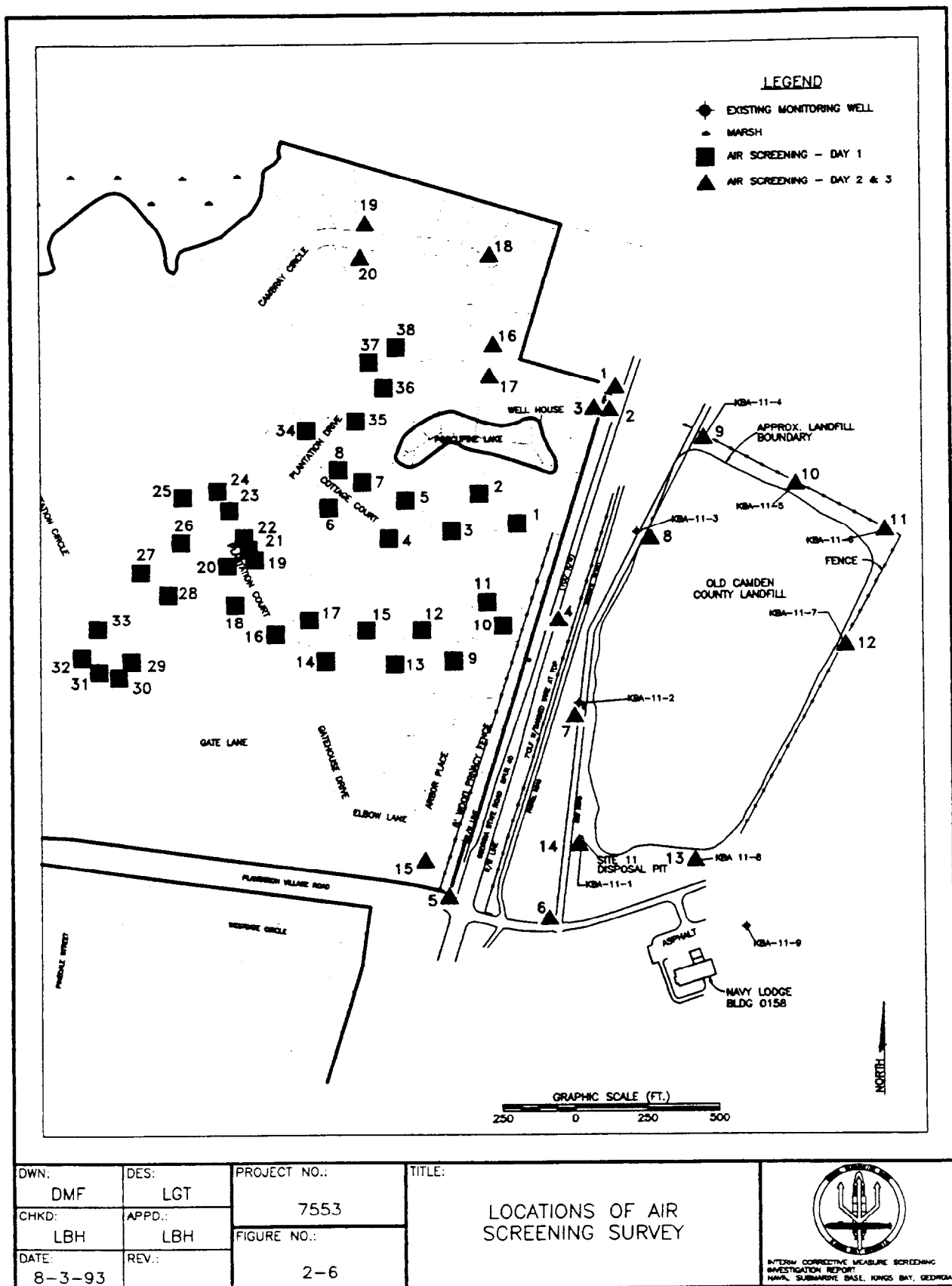
locations within the plume were submitted to the off-site laboratory for confirmation analysis. This accounts for 13 of 24 total PIW off-site laboratory analyses. Sampling was conducted from October 28 to November 4, 1992. Samples were placed in 40 milliliter (ml) vials directly from spigots or sprinkler heads. When samples were collected from sprinkler heads, the heads were removed so that samples could be collected from a steady flow with minimum aeration. Before sample collection, each well was purged for 15 minutes, during which time flow rates were measured by measuring the time required to fill a 6-gallon bucket. Flow rates were not measured for PIWs that were purged and sampled through sprinkler heads. Data collected included measurements of pH, specific conductance, and temperature. Physical and chemical data for the PIWs were collected to support the preliminary screening human health risk evaluation. Chemical data associated with PIW samples are not intended for use in characterization of the plume. The results of this sampling effort are discussed in Subsection 4.8 of this report.

**2.5 SURFACE WATER AND SEDIMENT SAMPLING.** Samples of sediment and surface water were collected from Porcupine Lake to evaluate the potential for migration of contaminants into surface water via groundwater discharge. Three surface water samples and three sediment samples were collected from Porcupine Lake on October 31, 1992. On October 19, 1992, two preliminary surface water samples (SW101 and SW102) were collected for on-site analysis to evaluate the need for air flux sampling. Figure 2-5 shows the locations of sediment and surface water samples. Surface water samples SW103, SW104, and SW105 were collected from a small boat using a Grab Sampler III made by Wheaton Instruments. The Grab Sampler III includes a glass container, stainless steel extension rod, and a head assembly constructed of stainless steel, polypropylene, and silicone parts. Surface water samples were collected from depths ranging from 6 inches to 1 foot above the bottom of the lake. Water depth was measured at each location using a weighted tape. Measurements of pH, specific conductance, and temperature were also made during collection of surface water samples. Collection of sediment samples was attempted using a sludge sampler at locations where surface water was collected, but sample retrieval was unsuccessful. Therefore, sediment samples were collected from the edge of the pond, as shown in Figure 2-5, using a hand auger. Water depth at the sediment sample locations was approximately 3 feet. Surface water and sediment samples were analyzed for target VOCs in the on-site laboratory. All sediment and three surface water samples were submitted to the off-site laboratory for analysis of TCL VOCs and TCL SVOCs. VOC analysis of sediment samples and all SVOC analyses were done using the CLP SOW for multimedia samples (USEPA, 1991a). The results of this sampling effort are summarized in Subsection 4.3 of this report.

**2.6 AIR SCREENING SURVEY.** An air screening survey conducted in the Crooked River Plantation Subdivision and at the landfill evaluated the potential emission of vinyl chloride from contaminated groundwater through the soil. The survey consisted of replicate measurements in low-lying areas or depressions accessible to the field crew. Wind speed and direction, temperature, barometric pressure, relative humidity, precipitation, and general weather conditions were monitored and recorded during the survey. Figure 2-6 shows the survey locations for air monitoring. Background locations are not shown on Figure 2-6, but are described in the following paragraph.

Multiple background air screening measurements were made each day during the air screening survey, which lasted 4 days. Background readings were collected at two





at a location approximately 1,000 feet east of the landfill at the intersection of James Madison Road and Pine Loop Road. On October 29 and November 4, 1992, background readings were made at an indoor location approximately 3.5 miles south-southwest of the landfill.

The air survey used direct reading instrumentation calibrated for vinyl chloride. On October 28 and 29, 1992, measurements were taken with a Bruel & Kjaer (B&K) Type 1302 Multi-gas Monitor that measures vinyl chloride concentrations by photoacoustic infrared spectroscopy. The detection limit of the B&K analyzer was 0.2 parts per million (ppm). On November 3 and 4, 1992, a Foxboro Miran 1B2 Infrared analyzer was used, because problems were encountered with the B&K monitor on October 29, 1992. The Miran was also calibrated to measure vinyl chloride; however, the detection limit for the Miran was 0.8 ppm. Both analyzers were calibrated at the factory prior to mobilization. The survey results are summarized in Subsection 4.4 of this report.

**2.7 DECONTAMINATION PROCEDURES.** All hydrocone and vapor cone sampling equipment that came in contact with sample material was cleaned as follows:

1. Steam-cleaned with potable water.
2. Washed with Alconox™ and distilled water.
3. Rinsed with distilled water.
4. Rinsed with pesticide-grade isopropanol.
5. Rinsed with deionized, organic-free water.
6. Air dried.
7. Wrapped in aluminum foil.

Decontamination fluids were collected in the decontamination area, which was bermed with timbers and lined with black plastic. Decontamination water collected on the plastic was allowed to evaporate.

Periodically, water collected in the decontamination area and unused portions of groundwater samples from on-site analyses were returned to the site. The water was disposed of within the area of contamination (within the landfill boundaries) in accordance with the USEPA guidance for management of investigation-derived waste (USEPA, 1991b).

Decontamination of equipment used to collect samples from Porcupine Lake followed Steps 2 through 7, above.

**2.8 LOCATION SURVEY.** Piezocone and hydrocone sampling locations were surveyed by a Georgia-licensed surveyor provided under subcontract. A closed-loop horizontal and vertical location survey was done to establish each vapor cone, piezocone, and hydrocone location with 0.1 foot of horizontal and 0.01 foot of vertical accuracy. Horizontal locations were tied to existing control points on the base and met the requirements of a third-order Class III Survey. Horizontal measurements are precise to 1 foot in 10,000 feet. Vertical elevations are relative to MLW and horizontal measurements are relative to State plane coordinates, consistent with other NSB Kings Bay survey data.

**TAB HERE   TAB HERE   TAB HERE   TAB HERE   TAB HERE**

### 3.0 QUALITY ASSURANCE PROGRAM AND DATA QUALITY ASSESSMENT

This section summarizes the analytical program for on-site and off-site analyses of sediment samples, surface water samples, PIW samples, vapor cone samples, and groundwater samples collected during Interim Corrective Measure Screening Investigation field activities at Site 11. In addition, it assesses on-site and off-site data quality and useability and compares on-site and off-site analytical results.

**3.1 ANALYTICAL PROGRAM.** Field activities during the screening investigation included the collection and chemical analysis of groundwater and PIW samples, surface water samples, sediment samples, and vapor cone samples. All samples were collected in accordance with procedures outlined in the Quality Assurance Project Plan, Appendix A, of the NSB Kings Bay RFI/SI Work Plan (ABB-ES, 1991).

**3.1.1 On-Site Chemical Analysis** Samples collected for on-site analysis were analyzed for target VOCs using a gas chromatographic (GC) field laboratory. The analytical method used was a modification of the USEPA 8010/8020 purge-and-trap GC method as described in the Interim Corrective Measure Screening Investigation Work Plan (ABB-ES, 1992c). Table 3-1 summarizes the sampling and analysis program for samples collected for on-site laboratory analysis.

**3.1.1.1 On-Site Analytical Method** Modifications to the USEPA 8010/8020 Method are summarized in this subsection. Samples were analyzed using an LSC-2000 purge-and trap unit connected to a Hewlett-Packard™ 5890 GC. A DB-624 75-meter megabore column was used for compound separation. For efficiency, two GCs were used, each with a purge-and-trap unit and two detectors, a photometric ionization detector and an electrolytic conductivity (Hall) detector. A standard sample volume of 25-ml was used for each analysis. The following run conditions were established:

- LSC-2000 purge time = 6 minutes
- LSC-2000 desorb time = 3 minutes
- LSC-2000 bake time = 5 minutes
- HP 5890 injection port temperature = 225 °C
- HP 5890 detector port temperature = 275 °C
- HP 5890 initial oven temperature = 35 °C
- HP 5890 oven temperature ramp = 6 °C per minute
- helium carrier flow = 10 ml per minute
- helium make-up flow = 20 ml per minute
- hydrogen make-up flow = 75 ml per minute

**3.1.1.2 Performance Criteria** The quality control (QC) criteria for the on-site analytical method were established to monitor method performance. An initial three-point calibration for quantitation (low, mid-range, and high concentrations) was performed for each instrument. Target compounds and reporting limits are presented on Table 3-2. Instrument stabilities were monitored every 24 hours with a calibration standard at the mid-range concentration. The quantitation performance criterion for operation was agreement of the check standard with the three-point calibration curve to within 30 percent. Samples were to be analyzed only if no more than one compound per

Table 3-1 Summary of Sampling and Analysis Program for Samples Collected for On-site Analysis

Type of Sampling	Number of VOC Analyses
Groundwater	142
Private Irrigation Wells	51
Surface Water	3
Sediment	3
Soil Vapor	22
Quality Control Samples	
Field Duplicates	25
MS/MSD	11
Equipment Rinseate Blanks	14
Method Blanks	41

Notes:

VOC = Volatile Organic Compounds

MS/MSD = Matrix spike/Matrix Spike Duplicate

Table 3-2 Target Compounds and Reporting Limits for On-site Analysis

Compound Name	Reporting Limit ( $\mu\text{g/l}$ )
Vinyl Chloride	2.0
trans-1,2-Dichloroethene	5.0
cis-1,2-Dichloroethene	5.0
Trichloroethene	5.0
Tetrachloroethene	5.0
Benzene	5.0
Toluene	5.0
Ethylbenzene	5.0
m/p-Xylene	10
o-Xylene	5.0

Note:  $\mu\text{g/l}$  = micrograms per liter

detector (a total of 10 percent of the target compounds) exceeded these criteria. If the standard did not meet this criterion, a second standard was analyzed. If this second standard did not meet criteria, a new calibration curve was prepared.

The identities of the target compounds were based on comparison with the retention times for the standards. Retention time windows of plus or minus 3 percent were established, based on the most recent calibration curve. For some cases, especially vinyl chloride, the peak was so broad that a 3 percent retention time window was not adequate and operator judgment was applied.

Every 24 hours, a method blank of deionized water was analyzed to confirm that no target compounds were introduced by sample handling and analysis. The method blank criterion was met if no target compounds present above the reporting limit for the instrument. A surrogate solution containing 100 µg/l of bromofluorobromine (BFB) was injected into each sample to determine percentage recoveries. The recovery range of 30 to 170 percent was established as one of the operating criteria for on-site analyses.

**3.1.2 Off-site Analysis** In accordance with the Interim Corrective Measure Screening Investigation Work Plan (ABB-ES, 1992c), a minimum of 10 percent of all samples collected for on-site VOC analysis and all samples collected for SVOC analysis were submitted to a contract laboratory for chemical analysis. Table 3-3 summarizes the sampling and analysis program for samples collected for off-site analysis. Samples for VOC and SVOC analyses were analyzed according to the USEPA CLP SOW for multi-media samples (USEPA, 1991a). Naval Energy and Environmental Support Activity (NEESA) Level D documentation (NEESA, 1988) was used for VOC and SVOC analyses. Appendix C contains validated Level D Data. Table 3-4 lists the TCL SVOCs analyzed in samples and corresponding Contract Required Quantitation Limits (CRQLs).

Because many of the target VOCs currently have Federal Primary Drinking Water Maximum Contaminant Levels (MCLs) below their respective CLP CRQLs, it was necessary to achieve lower reporting limits for VOCs. Based on VOC Method Detection Limit (MDL) studies performed and submitted by the contract laboratory, lower reporting limits for VOCs were achieved. Table 3-5 lists the TCL VOCs, their corresponding MDLs, and the reporting limits used during this investigation. All reporting limits listed in Table 3-5 are lower than corresponding Federal Primary Drinking Water MCLs. Appendix D contains data supporting the MDL study.

**3.2 DATA QUALITY ASSESSMENT.** Data generated by the on-site and off-site laboratories were reviewed against applicable performance criteria. In addition, data quality indicators of precision, accuracy, representativeness, comparability and completeness (PARCC) were evaluated and established for both on-site and off-site data.

**3.2.1 On-Site Data Quality and Use** All samples collected for on-site analysis during the screening investigation were properly preserved, placed in coolers, and packed with bagged ice immediately after collection. All samples remained in the custody of an investigation team member until delivery to the on-site laboratory.

Table 3-3 Summary of Sampling and Analysis for Samples Collected for Off-site Analysis

Type of Sampling	Number of Laboratory Analyses	
	VOC	SVOC
Groundwater	17	2
Private Irrigation Wells	24	0
Surface Water	3	3
Sediment	3	3
Field Duplicates		
Groundwater	2	1
Private Irrigation Wells	3	0
Surface Water	1	1
Sediment	1	1
Quality Control Samples		
Trip Blanks	15	0
Equipment Rinsate Blanks	11	2
Source Water Blanks	9	0

Notes:

VOC = Volatile Organic Compounds

SVOC = Semivolatile Organic Compounds

Table 3-4 Target Compound List and Contract Required Quantitation Limits (CRQLs) for Off-site Laboratory Analysis of Semivolatile Organic Compounds

	CRQL	
	Soil (µg/kg)	Water (µg/l)
<b>Semivolatile Organic Compounds (64 total)</b>		
<b>Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration, USEPA Document No. OLM01.0, 1991.</b>		
Phenol	330	10
Acenaphthene	330	10
bis(2-Chloroethyl)Ether	330	10
2,4-Dinitrophenol	800	25
2-Chlorophenol	330	10
4-Nitrophenol	800	25
1,3-Dichlorobenzene	330	10
Dibenzofuran	330	10
1,4-Dichlorobenzene	330	10
2,4-Dinitrotoluene	330	10
1,2-Dichlorobenzene	330	10
Diethylphthalate	330	10
2-Methylphenol	330	10
4-Chlorophenyl-phenylether	330	10
2,2'-oxybis(1-Chloropropane)	330	10
Fluorene	330	10
4-Methylphenol	330	10
4-Nitroaniline	800	25
N-Nitroso-Di-n-Propylamine	330	10
4,6-Dinitro-2-methylphenol	800	25
Hexachloroethane	330	10
N-Nitrosodiphenylamine	330	10
Nitrobenzene	330	10
4-Bromophenyl-phenylether	330	10
Isophorone	330	10
Hexachlorobenzene	330	10
2-Nitrophenol	330	10
Pentachlorophenol	800	25
2,4-Dimethylphenol	330	10
Phenanthrene	330	10
bis(2-chloroethoxy)Methane	330	10
Anthracene	330	10

See notes at end of table.

Table 3-4 (continued) Target Compound List and Contract Required Quantitation Limits (CRQLs) for Off-site Laboratory Analysis of Semivolatile Organic Compounds

	CRQL	
	Soil (µg/kg)	Water (µg/l)
2,4-Dichlorophenol	330	10
Carbazole	330	10
1,2,4-Trichlorobenzene	330	10
Di-n-Butylphthalate	330	10
Naphthalene	330	10
Fluoranthene	330	10
4-Chloroaniline	330	10
Pyrene	330	10
Hexachlorobutadiene	330	10
Butylbenzylphthalate	330	10
4-Chloro-3-methylphenol	330	10
3,3'-Dichlorobenzidine	330	10
2-Methylnaphthalene	330	10
Hexachlorocyclopentadiene	330	10
2,4,6-Trichlorophenol	330	10
2,4,5-Trichlorophenol	800	25
2-Chloronaphthalene	330	10
2-Nitroaniline	800	25
Dimethylphthalate	330	10
Acenaphthalene	330	10
2,6-Dinitrotoluene	330	10
3-Nitroaniline	800	25
Benzo(a)anthracene	330	10
Chrysene	330	10
bis(2-Ethylhexyl)phthalate	330	10
Di-n-octylphthalate	330	10
Benzo(b)fluoranthene	330	10
Benzo(k)fluoranthene	330	10
Benzo(a)pyrene	330	10
Ideno(1,2,3-cd)pyrene	330	10
Dibenz(a,h)anthracene	330	10
Benzo(g,h,i)perylene	330	10

Notes: µg/kg = micrograms per kilogram  
µg/l = micrograms per liter

Table 3-5 Method Detection Limits (MDLs) and Reporting Limits for Volatile Organic Compounds

	MDL (µg/l)	Reporting Limit (µg/l)
<b>Volatile Organic Compounds (37 total)</b>		
<b>Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration, USEPA Document No. OLM01.0, 1991.</b>		
Chloromethane	0.203	1
cis-1,3-Dichloropropene	0.274	1
Bromomethane	0.396	1
Trichloroethene	0.185	1
Vinyl Chloride	0.165	1
Dibromochloromethane	0.190	1
Chloroethane	0.147	1
1,1,2-Trichloroethane	0.268	1
Methylene Chloride	9.712	10
Benzene	0.235	1
Acetone	3.491	5
trans-1,3-Dichloropropene	0.097	1
Carbon Disulfide	0.114	1
Bromoform	0.230	1
1,1-Dichloroethene	0.175	1
2-Hexanone	0.465	5
1,1-Dichloroethane	0.205	1
4-Methyl-2-Pentanone	0.746	5
cis-1,2-Dichloroethene	0.215	1
Tetrachloroethene	0.340	1
trans-1,2-Dichloroethene	0.254	1
1,1,2,2-Tetrachloroethane	0.391	1
Chloroform	0.285	1
Toluene	0.167	1
1,2-Dichloroethane	0.160	1
Chlorobenzene	0.238	1
2-Butanone	0.709	5
Ethylbenzene	0.195	1
1,1,1-Trichloroethane	0.221	1
Styrene	0.240	1
Carbon Tetrachloride	0.354	1
Xylenes (total)	0.141	1
Bromodichloromethane	0.144	1
1,3-Dichlorobenzene	0.126	1
1,2-Dichloropropane	0.236	1
1,4-Dichlorobenzene	0.164	1
1,2-Dichlorobenzene	0.222	1

Note: µg/l = micrograms per liter

**3.2.1.1 Analytical Performance** Review of analytical data indicated the on-site laboratory generally met applicable analytical QC criteria for VOC analyses. Extraction and analysis holding times for all sample lots were met. Problems with instrument stability were noted for vinyl chloride, especially between October 27 and November 4, 1992. During this period, continuing calibration standards regularly exceeded the QC criteria of 30 percent. This problem was especially acute on October 29 and 30, 1992, when calibration standards indicated that the Hall detector lost sensitivity to vinyl chloride. This resulted in underestimates of the true concentrations of vinyl chloride in the samples analyzed on these two days. As a result, the vinyl chloride could not be quantified during this period and only the presence or absence of vinyl chloride could be reported. Samples in which vinyl chloride was detected, but not quantified, are as follows:

H11826  
H11845  
H11940  
H11950  
CRP PW-22  
CRP PW-6  
CRP PW-7

Percentage surrogate recoveries, based on BFB, were calculated for individual samples and are in the field analytical logbook. Overall, 96 percent of surrogate recoveries fell within the established 30 to 170 percent recovery range. Method blank and equipment rinseate blank results indicated that there were no target compounds introduced as a result of the sample handling and analysis procedures.

**3.2.1.2 On-site Data Use** Performance criteria for the on-site analytical method, described in Subsection 3.1.1.2, were used to assess the quality of data generated by the field laboratory. PARCC parameters were established based on the extent of conformance to these performance criteria.

The accuracy and precision of the on-site analytical method were established. Accuracy was calculated based on the range of matrix spike percentage recoveries (%R) for matrix spike/matrix spike duplicate (MS/MSD) samples and precision was calculated based on the relative percentage difference (RPD) between spike results for MS/MSD samples. Calculation of %R and RPD are as follows:

$$\%R = (\text{spike sample result} / \text{concentration of spike added}) \times 100 \quad (1)$$
  
and

$$RPD = \frac{|\text{MS result} - \text{MSD result}|}{(\text{MS result} + \text{MSD result}) / 2} \times 100. \quad (2)$$

MS/MSD samples were analyzed every 20 samples for each matrix using a mid-level calibration standard containing all target compounds. Eleven sets of MS/MSD samples were analyzed and the precision and accuracy results for the target compounds are shown in Table 3-6. The accuracy and precision achieved by the on-site analyses were expected to have a greater range than off-site Level D laboratory analyses. Except for vinyl chloride, the accuracy range was 36 to 160

Table 3-6 Summary of Precision and Accuracy for On-site MS/MSD Analysis

Compound	MS/MSD Recovery Range (Accuracy)	RPD Range (Precision)
Vinyl Chloride	11-220	0-67
trans-1,2-Dichloroethene	36-160	4-65
cis-1,2-Dichloroethene	36-140	1-82
Trichloroethene	47-120	3-63
Tetrachloroethene	49-120	0-69
Benzene	40-120	3-73
Toluene	56-120	0-24
Ethylbenzene	56-120	0-26
m/p-Xylene	55-120	0-40
o-Xylene	51-125	0-45
USEPA Method 8010/8020	75-120	2-28

Notes:

RPD = Relative Percent Difference

MS/MSD = Matrix Spike/Matrix Spike Duplicate

percent and the precision range was 0 to 82 percent. For example, as a point of comparison, ranges for accuracy and precision for the established USEPA Method 8010/8020 in an off-site laboratory are 75 to 120 percent accuracy and 2 to 27.7 percent precision (USEPA, 1987). The net result is that the data produced by the on-site laboratory is of the same order of magnitude as that of the off-site laboratory.

Representativeness is a qualitative parameter that expresses how well the sampling represents the environmental conditions of the sampled media. Field duplicates were collected to give an indication of representativeness and to monitor method reproducibility. A total of 25 duplicate samples were collected and analyzed on site. Analytical results for duplicate samples are presented in Tables 4-1, 4-3, and 4-4 in Section 4.0 of this document. In general, results for field duplicates show good agreement with RPD values ranging from 0 to 45 percent.

The completeness of the on-site data set was measured by establishing what percentage of the data set was considered valid after data review. Valid results are defined as those results from analyses meeting the performance criteria defined by calibration checks and surrogate recoveries. The completeness for all analytes, except vinyl chloride, was determined to be 100 percent. For vinyl chloride, the completeness was determined to be 84 percent.

Comparability is often a qualitative indicator of the confidence with which one data set can be measured with another. The use of standard techniques to collect and analyze the samples helps to confirm comparable results. For this project, the results of the on-site analyses were compared to those of the off-site results using a set of statistical tests described in Subsection 3.2.3 of this document.

Overall, data generated by the on-site analytical laboratory met USEPA Level II criteria for field screening. Except for certain vinyl chloride data, the data are suitable for use in site characterization, engineering design, and evaluation of remedial alternatives.

**3.2.2 Off-site Data Quality and Use** All samples collected for off-site analysis were properly preserved, placed in coolers, and packed with bagged ice immediately after collection. All samples remained in the custody of an investigation team member until delivery to the courier service providing overnight shipment to the laboratory. All samples requiring off-site analysis were shipped, complete with chain-of-custody forms, to the contract laboratory within 24 hours for analysis. Upon arrival at the laboratory, the chain-of-custody and preservation of the samples were checked with the contents of each cooler. After verification, the chain-of-custody form was signed and the samples accepted for analysis.

Review of the field notebook and chain-of-custody forms did not indicate any non-conformance relative to field instrument calibration or sample handling. All required field QC samples were collected in conformance with the requirements of the USEPA, NEESA, and ABB-ES Quality Assurance Plans and the June 1988 NEESA "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program" (NEESA, 1988) (Document 20.2-047B). These

field QC samples included field duplicates, equipment rinseate blanks, source water blanks, and VOC trip blanks for each VOC sample shipment.

Analytical results for environmental samples collected during the investigation were evaluated and validated according to NEESA Level D QC criteria to establish data quality and useability. NEESA Level D documentation and validation requirements are equivalent to USEPA Level IV requirements. The data tables included in Appendix C reflect validation according to Level D criteria, which are described in Subsection 7.3.1 of NEESA Document 20.2-047B. The following subsections discuss analytical performance and the evaluation of field and laboratory QC samples.

**3.2.2.1 Analytical Performance** Data review and NEESA Level D validation were performed under subcontract. Review of analytical data indicated the laboratory generally met applicable analytical QC criteria for all chemical analyses. Extraction and analysis holding times for all sample lots were met. Appendix D contains the PARCC report submitted for all data collected during the screening investigation (Heartland Environmental Services, Inc., 1993).

For VOC analyses, all holding times, tuning criteria, internal standard/surrogate recoveries, and MS/MSD criteria were met. However, seven continuing calibration standards contained acetone, methylene chloride, bromoform, 1,1,2,2-tetrachloroethane, and 2-butanone with differences between 25 and 50 percent. For these compounds, qualification was only required for positive sample results. Bromoform, 1,1,2,2-tetrachloroethane, and 2-butanone were not detected in associated samples and, therefore, did not require qualification. Acetone and methylene chloride were detected in associated samples and results for these compounds have been appropriately qualified as estimated and flagged with a J qualifier. One additional continuing calibration standard contained acetone and 2-hexanone with differences between 50 and 90 percent. Only one sample associated with this standard, a trip blank (BT106FB), required qualification. Sample quantitation limits for these two compounds were qualified as estimated and flagged with a UJ qualifier. The exceedance of QC criteria by calibration compounds is common and sample results qualified as estimated because of calibration deficiencies are considered useable data according to risk assessment guidance (USEPA, 1989a and 1992a).

For SVOC analyses, all holding times, tuning criteria, and internal standard/surrogate recovery criteria were met. However, five continuing calibration standards contained compounds with differences between 25 and 50 percent. No qualification of data was required because compounds exceeding criteria were not detected in associated samples. One set of MS/MSDs contained three compounds with spike recoveries above QC limits. However, no qualification of data was required because associated samples did not contain these compounds.

Analytical method blanks associated with certain VOC sample analyses contained detectable concentrations of acetone and methylene chloride. Acetone and methylene chloride are common laboratory solvents and are frequently observed artifacts in laboratory method blanks. Table 3-7 summarizes analytical method blank results for VOCs. Analytical blanks associated with SVOC sample analyses contained detectable concentrations of bis(2-ethylhexyl)phthalate. Phthalate compounds are common laboratory and field contaminants that can originate from

Table 3-7 Summary of Volatile Organic Compounds Detected in Method Blanks

Blank ID	Methylene chloride (ug/l)	Acetone (ug/l)	Associated Samples				
VBW1170	16	5 U	11H10116, BT102FB,	BS101ER, 11H10632,	BT101FB, BS103ER,	11H10342, BT103FB	BS102ER
VBW1189	5	5 U	11H11134, BS102FB, BS106ER,	BS105ER, BS103FB, BS106FB	BT104FB, BT105FB,	11H11346, 11H11625,	BS101FB 11H11625D
VBW1276	18	5 U	CRP-PW1, CRP-PW9,	CRP-PW2, BT107FB,	CRP-PW3, 11H11835,	CRP-PW5, 11H11950,	CRP-PW6 CRP-PW17 BT108FB
VBW1295	5	5 U	11H12015, BT109FB,	11H12045, BS109ER,	CRP-PW22,	CRP-PW21,	CRP-PW26
VBW1302	5	5 U	11SW103,	11SW104,	11SW104D,	11SW105,	BT110FB
VBW1311	8	5 U	CRP-PW29, 11H12716,	CRP-PW29D, 11H12740,	CRP-PW32, BS110ER,	CRP-PW33, BT111FB	CRP-PW39
VBW1329	8	5 U	11H12811, CRP-PW45,	CRP-PW41, BT112FB,	11H12748, BS111ER,	11H12748D, CRP-PW46,	CRP-PW43 CRP-PW47
VBW2329	2	5 U	CRP-PW42, BT113FB,	CRP-PW48, BS104FB,	CRP-PW50, BS105FB,	CRP-PW51, BS106FB	CRP-PW51D
VBW1438	3	5 U	BS107FB,	BS121ER,	BT117FB,	11H14229	
VBW2276	5	5 U	CRP-PW3D,	CRP-PW4,	BS108ER		
VBS1302	23 ug/kg	4 J ug/kg	11SD101,	11SD102,	11SD102D,	11SD103	
	<b>bis(2-Ethylhexyl)phthalate (ug/l)</b>						
SB34302	1 J		11SW105				
SB34443	35		11H14621,	11H14621D,	BS123ER		

Notes: J = value is considered estimated because it is less than the Contract Required Quantitation Limit

U = compound was not detected at the stated quantitation limit

ug/l = micrograms per liter

ug/kg = micrograms per kilogram

many types of plastic gloves, containers, and tubing used during field and laboratory operations. Table 3-7 summarizes analytical method blank results for SVOCs.

Qualifications of sample results for VOC and SVOC compounds associated with blank contamination were made according to NEESA Level D QC guidelines and are as follows.

- If a chemical is present in a method blank but not in associated samples, the sample results are reported unqualified at the Sample Quantitation Limit (SQL). For the five common VOC and SVOC laboratory contaminants, the CRQLs are as follows:

	<u>Aqueous</u>	<u>Soil</u>
Methylene chloride	10 µg/l	10 µg/kg
Acetone	5 µg/l	5 µg/kg
2-Butanone	5 µg/l	5 µg/kg
Toluene	1 µg/l	1 µg/kg
<u>Phthalates</u>	<u>10 µg/l</u>	<u>330 µg/kg</u>

µg/l = micrograms per liter

µg/kg = micrograms per kilogram

- If a chemical is present in the sample above the SQL, but is less than five times the concentration detected in the associated blanks (10 times for the chemicals listed above), qualify the result as undetected, "U." The "U" designation signifies that the chemical was analyzed for but not detected.
- If the sample result is below the SQL and less than five times the blank value (10 times for the chemicals listed above), qualify by reporting as undetected at the SQL.
- If the chemical is present at more than five times the SQL (10 times for the above chemicals), report as an unqualified result.

**3.2.2.2 Evaluation of Field QC Samples** Nine source water blanks, 15 trip blanks, and 13 rinseate blanks were collected during field activities. The nine source water blanks represented organic-free, deionized water used as a final rinse during equipment decontamination procedures, regular deionized water used as an intermediate rinse during equipment decontamination procedures, and potable water used to steam-clean equipment. The 13 equipment rinseate samples were collected during decontamination procedures involving hydrocone equipment.

The VOCs methylene chloride and/or acetone were detected in three trip blanks as shown in Table 3-8. Sample results for VOC compounds associated with trip blank contamination are qualified according to NEESA Level D QC guidelines. Sample results for methylene chloride and acetone associated with trip blank contamination were appropriately qualified as undetected because sample values were less than 10 times the trip blank concentration.

Table 3-8 Summary of Compounds Detected in Rinseate Blanks, Source Water Blanks, and Trip Blanks

Equipment Rinseate Blanks									
Compounds Detected ( $\mu\text{g/l}$ )	BS101ER	BS102ER	BS103ER	BS106ER	BS108ER	BS109ER	BS110ER	BS111ER	BS114ER
Acetone <sup>1</sup>	22	3 J	7	8 J	5 J	50 J	4 J	7	7 J
Carbon disulfide	1 U	1 U	51	1 U	70	74	1 U	1	6
Methylene chloride <sup>1</sup>	17 U	16 U	14 U	2 U	2 U	3 U	8 U	2 U	11 U
Toluene	1 U	1 U	1 U	1 U	2	3	1 U	1 U	1
Xylenes (total)	1 U	1 U	1 U	1 U	1 U	1	1 U	1 U	1 U

Source Water Blanks				Trip Blanks		
Compounds Detected ( $\mu\text{g/l}$ )	BS101FB	BS104FB	BS108FB	BT107FB	BT109FB	BT114FB
Acetone <sup>1</sup>	5 U	5 U	5 U	4 J	4 J	5 U
Methylene chloride <sup>1</sup>	4 U	2 U	2 U	27 U	4 U	15 J
Bromodichloromethane	15	11	7	1 U	1 U	1 U
Bromoform	1 U	2	1 U	1 U	1 U	1 U
Chloroform	11	12	7	1 U	1 U	1 U
Dibromochloromethane	12	10	6	1 U	1 U	1 U

## Notes:

BSXXXER = hydrocone rinseate blank

BSXXXFB = source water blank

BTXXXFB = volatile trip blank

 $\mu\text{g/l}$  = micrograms per liter

U = compound was not detected at the stated concentration

1 = sample result(s) are considered estimated and flagged with a J qualifier because an associated continuing calibration standard exceeded QC limits.

2 = sample results are considered estimated and flagged with a J qualifier because concentrations are less than the Sample Quantitation Limit.

The VOCs bromodichloromethane, bromoform, chloroform, and dibromochloromethane were detected in the three source water blanks representing potable water. VOCs were not detected in the blanks representing organic-free, deionized water and regular deionized water. Chloroform, bromoform, bromodichloromethane, and dibromochloromethane are trihalomethanes that form in water chlorinated for drinking water disinfection. No qualification of data was required because none of the environmental samples associated with these field blanks contained detectable concentrations of these trihalomethanes.

Nine of the 13 equipment rinseate blanks contained detectable concentrations of VOCs that could not be attributed to method blank contamination (see Table 3-8). Xylenes were detected in one rinseate blank, BS109ER, but were not detected in environmental samples associated with this blank. The presence of toluene in three rinseate blanks may be attributable to poor equipment decontamination procedures following the collection of hydrocone samples (H11835 and H13642), which contained relatively high concentrations of toluene, 120 and 61  $\mu\text{g/l}$ , respectively. One hydrocone sample, H12045, contained toluene at a concentration similar to the concentration detected in the corresponding rinseate BS109ER (4  $\mu\text{g/l}$ ). The toluene result for H12045 is attributed to incomplete decontamination and has been qualified as not detected (4 U  $\mu\text{g/l}$ ).

Except for one rinseate sample (BS111ER), the presence of carbon disulfide in rinseate blanks cannot be directly attributed to equipment decontamination because none of the samples associated with these rinseates contained carbon disulfide at concentrations higher than the rinseate concentration. Concentrations of carbon disulfide in samples that were lower than concentrations found in associated rinseate blanks are considered to be artifacts and have been qualified as not detected. Because the presence of carbon disulfide in rinseate samples is sporadic, and a source of carbon disulfide in the rinseates cannot be established, the analytical measurement of carbon disulfide in all environmental samples collected during the investigation is considered to have a positive bias.

Nine of the 11 rinseate samples submitted for VOC analysis contained acetone at concentrations ranging from 3 J  $\mu\text{g/l}$  to 50 J  $\mu\text{g/l}$ . Three possible sources of acetone in rinseate blanks are groundwater samples containing high concentrations of acetone, isopropanol used during equipment decontamination that has partially degraded to form acetone or contained acetone as an impurity, and/or acetone used during sample preparation at the laboratory. Sample results associated with rinseate blank contamination are qualified according to NEESA Level D QC guidelines. Qualification criteria for blank contamination are discussed in Subsection 3.2.2.1 of this document. Table 3-9 provides a summary of acetone detected in groundwater samples and in associated rinseate samples and sample results after NEESA Level D qualification.

The prevalence of acetone in the rinseate blanks indicates it is present as a sampling artifact and suggests a positive bias in the analytical measurement of acetone in all environmental samples collected during this investigation. The source of the acetone may be from incomplete rinsing after decontamination and can vary in any environmental sample.

Review of VOC and SVOC results for field duplicates generally showed good agreement. Tables 1.1 and 1.1.1 in Appendix D summarize analytical results for

Table 3-9 Summary of Acetone Detected in Rinseate Blanks and Associated Groundwater Samples

Sample Number	Sample Concentration ( $\mu\text{g/l}$ )	Associated Rinseate Concentration ( $\mu\text{g/l}$ )	Sample Concentration after Qualification ( $\mu\text{g/l}$ )
H10116	170	22	170
H10342	170	3 J	170
H10632	14	7	14 U
H11134	58	5 U	58
H11346	28	5 U	28
H11625	10 U	8 J	10 U
H11835	330 J	5 J	330 J
H11950	38	5 J	38 U
H12015	40	50 J	40 U
H12045	54	50 J	54 U
H12716	13	4 J	13 U
H12740	93	4 J	93
H12748	160	7	160
H12811	8	7	8 U
H13642	100 J	7 J	100 J
H13646	24	7 J	24 U
H14229	6	5 U	6

Notes:

U = compound was not detected at the stated concentration  
J = estimated value  
 $\mu\text{g/l}$  = micrograms per liter

compounds detected in duplicate samples collected during the investigation. With one exception, all duplicate results outside control limits were detected at or near the instrument detection limit. Carbon disulfide was detected in replicate groundwater samples from one hydrocone location (11H12748) at 5 and 13  $\mu\text{g/l}$ . The discrepancy between results may be attributed to sampling techniques, analytical techniques, or heterogeneity of the sample matrix.

**3.2.2.3 Off-site Data Use** The quality of the off-site sampling data generated during the field program met the established field QC criteria and was traceable to sample location. The data generated meet Level D Data Quality Objectives (DQOs) established for the Interim Corrective Measure Screening Investigation and are acceptable for use in site characterization and evaluation.

Blank qualifications for VOCs resulted in elevated detection limits for the chemicals discussed earlier. The widespread occurrence of acetone and the unknown origin of carbon disulfide in rinseate blanks render data for acetone and carbon disulfide suspect for groundwater and PIW samples containing these compounds at concentrations that could not be directly attributed to contamination. The source of acetone and carbon disulfide in rinseate samples will be further investigated during future field programs at NSB Kings Bay.

**3.2.3 Statistical Comparison of Field Laboratory Results and Off-Site Laboratory Results** A statistical analysis of groundwater contamination data was performed on the analytical results from on-site analysis and results from off-site laboratory analysis. Two sets of field data were collected: hydrocone groundwater samples and groundwater samples obtained from PIWs.

The hydrocone groundwater samples were collected from 46 locations at various depths to provide a total of 144 samples. In addition, 16 duplicate samples were collected. Of these 144 samples, 17 were also analyzed at an off-site laboratory for confirmation. The PIW samples were collected from 51 locations with 25 sent to the off-site laboratory for confirmation. Because of instrument instability at the on-site laboratory over a 2-day period, vinyl chloride results for those 2 days were removed from the analysis.

With both sets of data, a problem in comparing the results from the two different analytical techniques is the disparity between quantification or detection limits. For most VOCs, the on-site analytical laboratory detection limits were 5  $\mu\text{g/l}$  (except vinyl chloride at 2  $\mu\text{g/l}$  and xylenes at 10  $\mu\text{g/l}$ ), whereas the off-site laboratory detection limit was 1  $\mu\text{g/l}$ . A problem arises when comparing laboratory results reported at concentrations below the field analytical detection limit. Because the concentrations observed are very close to the detection limit, the standard practice of substituting the detection limit or one-half the detection limit when the results were reported as "less than" values would bias the comparison. Because most of the data were below the detection limit, the statistical analysis would be comparing two different detection limits, not analytical results. To compare the results from the two analytical procedures, it was necessary to transform the data to a more comparable form. Therefore, for this evaluation, the off-site laboratory results were transformed to match up with the corresponding field detection limits. If the field result was below the detection limit and the corresponding off-site laboratory value was reported at any level less than this value (whether it be a detected concentration or a "less than" value), then the laboratory value was transformed to the field result. For example, suppose the field GC result for VOC "X" was "<5" and the off-site laboratory result was "2." Because the field result was

below the detection limit and the off-site laboratory value was also less than this value, the off-site laboratory value was transformed to "<5." The evaluation is concerned with differences that are above the field GC detection limit because the true value of a reported "<5" result cannot be quantified.

Because the vast majority of data is below the detection limit, the preferred standard Gaussian parametric procedures such as ANOVA (analysis of variance) and paired t-Test would be inappropriate. The Wilcoxon Signed Rank nonparametric procedure was employed to test for differences between the paired data sets. Nonparametric procedures do not require the data to follow a known distribution as do most parametric procedures such as ANOVA and t-Tests. The Wilcoxon procedure does not require the data to be normally or lognormally distributed and therefore is more appropriate for this analysis. The procedure relies on the fact that if paired data were comparable then the differences would be symmetrically distributed with a mean difference of zero. If the distribution of differences is skewed in either direction this would be evidence that the two data are not comparable. The first step in this procedure is to rank the differences between the paired on-site and off-site data results and assign the ranks a sign, say "+" for on-site being the greater value and "-" for off-site being the greater value. If paired data are comparable then the "+" ranks and "-" ranks would be approximately evenly distributed and the sum of the "+" ranks and "-" ranks would not be significantly different (i.e., the sum would not be significantly greater or less than zero). The Wilcoxon Signed Rank test deletes ties (zero differences) so the probability levels are calculated for only non-zero differences. The results of the analyses are presented in Tables 3-10 (hydrocone) and 3-11 (PIW).

The results from on-site and off-site analyses for all compounds, except for vinyl chloride and cis-1,2-dichloroethene, are statistically similar. Vinyl chloride and cis-1,2-dichloroethene data from the on-site and off-site analyses had a statistical difference. Vinyl chloride concentrations detected by on-site analysis were frequently not confirmed by off-site analysis. This is attributed to unavoidable loss of vinyl chloride due to volatilization during transport to the off-site laboratory. Conversely, cis-1,2-dichloroethene concentrations reported by off-site analysis were not consistent with concentrations reported by on-site analysis. The off-site analysis included mass spectroscopy in conjunction with GC. Some compounds, such as cis-1,2-dichloroethene, are better suited for quantification using mass spectroscopy. The statistical difference between cis-1,2-dichloroethene data is attributed to difference in performance capabilities of GC alone and GC combined with mass spectroscopy.

Based on the measured precision and accuracy of the on-site and off-site results, and a statistical test for comparability of results, the on-site data can be used to augment the off-site data for site characterization.

Table 3-10 Wilcoxon Signed Rank Test Results: Hydrocone Data

Analyte	Non-Zero Differences	Sum On-site Ranks	Sum Off-site Ranks	Probability Level	Conclusion
Benzene	3	1	5	.250	ACCEPT
Ethylbenzene	4	2	8	.188	ACCEPT
Tetrachloroethene	1	1	0	N/A	ACCEPT <sup>1</sup>
Toluene	6	3	18	.078	ACCEPT
Trichloroethene	3	2	4	.375	ACCEPT
Vinyl Chloride	7	28	0	.008	REJECT
Xylenes (Total)	3	0	6	.125	ACCEPT <sup>1</sup>
cis-1,2-dichloroethene	7	0	28	.008	REJECT
trans-1,2-dichloroethene	1	0	1	N/A	ACCEPT <sup>1</sup>

Table 3-11 Wilcoxon Signed Rank Test Results: Private Well Data

Analyte	Non-zero Differences	Sum On-site Ranks	Sum Off-site Ranks	Probability Level	Conclusion
Benzene	0	0	0	N/A	ACCEPT <sup>1</sup>
Ethylbenzene	1	0	1	N/A	ACCEPT <sup>1</sup>
Tetrachloroethene	0	0	0	N/A	ACCEPT <sup>1</sup>
Toluene	0	0	0	N/A	ACCEPT <sup>1</sup>
Trichloroethene	0	0	0	N/A	ACCEPT <sup>1</sup>
Vinyl Chloride <sup>1</sup>	2	3	0	.250	ACCEPT <sup>1</sup>
Xylenes (Total)	0	0	0	N/A	ACCEPT <sup>1</sup>
cis-1,2-dichloroethene	3	0	6	.125	ACCEPT <sup>1</sup>
trans-1,2-dichloroethene	0	0	0	N/A	ACCEPT <sup>1</sup>

<sup>1</sup> - "Accept" indicates that there were too few quantifiable results to reject the hypothesis that the on-site laboratory and off-site laboratory results are similar. In order to reject at the 95% confidence limit there would have to be at least six quantifiable values - all ranks greater for either laboratory.

NA = not applicable

#### 4.0 RESULTS OF INVESTIGATIONS

4.1 RESULTS OF RECORDS SEARCH. Information obtained during the records search indicated little commercial development or commercial activity in the landfill area. Residential development in this area has occurred only during the past 10 years. During the 1980s, the Crooked River Plantation Subdivision, a residential development, was built on 260 acres. The only other development in the area researched is Mom and Pop Stores, Inc., located on the west side of Spur 40 south of the landfill.

The 6,000-acre area researched was originally part of a 12,000-acre tract purchased by ITT Rayonier, Inc., in 1952 from Georgia Timber Company. The land was used for tree farming. Rayland Company, Inc., obtained title to the property from ITT Rayonier in two separate deeds in 1981 and 1983. Rayland Company, Inc., is the land management subsidiary of ITT Rayonier. The county registrars office has a "Memorandum of Oil and Gas Lease" to the Amoco Production Company dated December 21, 1982. The oil and gas lease was released and voided by Amoco on March 26, 1986. There was no evidence of exploration or drilling activities during the period of the lease.

The following demographic information is taken from the HRS II documentation report (ABB-ES, 1992a). The population of Camden County is 30,882, based on the 1990 Census. The population growth rate of Camden County more than doubled during the 1980s because of the development of NSB Kings Bay. During the period from 1980 to 1990, approximately 10,000 jobs were created in Camden County as a result of this development. The population within a 4-mile radius of NSB Kings Bay is estimated to be 12,000. The population growth rate for Camden County through 2000 is expected to be approximately 35 percent.

4.2 GEOLOGIC AND HYDROGEOLOGIC INVESTIGATION RESULTS. Stratigraphic information was obtained from 15 piezocone penetrations around the landfill, on the western right-of-way of Spur 40, and in Crooked River Plantation Subdivision. Estimates of hydraulic conductivity were made during collection of groundwater samples using the hydrocone. Figure 2-1 shows the locations of piezocone penetrations and Figure 2-2 shows hydrocone penetrations.

Physical data gathered during piezocone penetrations are presented in Appendix G. Depths of piezocone penetrations ranged from 11 to 86 feet bgs. Four piezocone penetrations (P106, P107, P108, and P112) were relatively shallow, extending less than 25 feet bgs, because the penetrations were refused on very dense sand layers. The remaining 11 penetrations extended beyond depths of 40 feet bgs. The piezocone data indicate that the subsurface is comprised of layers of fine sand interbedded with silty and/or clayey fine sand. The density of the layers, as interpreted from the piezocone data, is generally medium dense and dense. No strata were identified that would act as a confining layer or barrier to vertical contaminant migration.

During collection of the groundwater samples using the hydrocone, the rate of filling of the 6.5-foot long sample chamber was recorded by the computer. This data was plotted to estimate permeability at specific intervals in the aquifer. The calculations were performed using Hvorslev's Basic Time Lag method. Hydraulic conductivity estimates associated with collection of groundwater samples using the hydrocone are generally consistent over the sampling area and with depth. The hydraulic conductivity estimates have been tabulated and are

presented in Appendix E. A total of 103 estimates were obtained. Hydraulic conductivity estimates range from  $2.2 \times 10^{-4}$  centimeters per second (cm/sec) (2.5 gallons per day per square foot [gal/day/ft<sup>2</sup>]) to  $1.0 \times 10^{-2}$  cm/sec (115 gal/day/ft<sup>2</sup>). Geometric means were calculated for four depth intervals for all 103 estimates, for hydrocone samples collected in the area of the landfill, and for hydrocone samples collected from off-site locations (see Appendix E). The four depth intervals include all sample depths and are 30 to 15 feet MLW, 15 to 0 feet MLW, 0 to -15 feet MLW, and -15 to -36 feet MLW. For all 103 estimates, the geometric mean of hydraulic conductivities ranges from  $1.6 \times 10^{-3}$  cm/sec (18.4 gal/day/ft<sup>2</sup>) for the lowermost interval (-15 to -36 feet MLW) to  $2.1 \times 10^{-3}$  cm/sec (24.2 gal/day/ft<sup>2</sup>) for the uppermost depth interval (30 to 15 feet MLW). In the area of the landfill, geometric means range from  $1.3 \times 10^{-3}$  cm/sec (14.9 gal/day/ft<sup>2</sup>) for the lowermost interval to  $2.3 \times 10^{-3}$  cm/sec (26.2 gal/day/ft<sup>2</sup>) for the uppermost interval. Geometric means for off-site estimates range from  $1.0 \times 10^{-3}$  cm/sec (11.9 gal/day/ft<sup>2</sup>) for the lowermost interval to  $3.4 \times 10^{-4}$  cm/sec (39.4 gal/day/ft<sup>2</sup>) for the uppermost interval. These data indicate that the surficial aquifer is relatively homogeneous and that hydraulic conductivity values decrease slightly with depth.

Seepage velocities were calculated using hydraulic conductivity values from the area of the landfill and an average hydraulic gradient of 0.003 feet per foot. This hydraulic gradient is based on water level measurements obtained on November 10, 1992, at the existing monitoring wells. These water levels represent the water table surface as shown on Figure 1-4. Based on these data, groundwater flow within the surficial aquifer is toward the west-northwest, however, localized variations to this direction of flow have been observed. In the southeast corner of the landfill near KBA-11-8, localized mounding of the groundwater creates a southerly component of flow. Flow is assumed to be Darcian (i.e., laminar, not turbulent) and the effective porosity is assumed to be 30 percent. Seepage velocities calculated from these data and assumptions range from 2.2 meters per year (m/yr) (7.3 feet per year [ft/yr]) to 15 m/yr (49 ft/yr), resulting in an estimated maximum distance of contaminant migration (due to advection) of 880 feet. Contaminant migration is affected by dispersive movement, actual hydraulic gradient (which may vary horizontally and vertically within the aquifer) and the influence of pumping wells, such as the PIWs.

**4.3 PORCUPINE LAKE INVESTIGATION.** The following subsections summarize information regarding the source of water for Porcupine Lake and the status of contamination based on VOC and SVOC analysis of surface water and sediment samples.

**4.3.1 Lake Water Source Evaluation** From November 1 through November 3, 1992, an engineering evaluation was conducted to evaluate the source(s) of water supply to Porcupine Lake. The evaluation consisted of a site visit, interviews, and/or telephone conversations with representatives of the City of St. Marys Public Works, the developer of the Crooked River Plantation Subdivision, local drilling companies, and the contractor that constructed the lake. Results of this evaluation indicate that Porcupine Lake is supported by groundwater discharge. The following information was obtained during the evaluation.

Reportedly, rapid groundwater flow from a depth of 4 feet bgs at the east end of the excavation was observed during construction of the lake. A temporary dike was constructed because the flow of water from the east end hindered excavation of the west end of the lake.

Two deep wells are present in the vicinity of the lake. The approximate locations of these two wells are shown in Figure 2-1. No boring logs were available for either of the wells. Reportedly, one well is 10 inches in diameter and extends approximately 320 to 380 feet bgs. Steel casing was set in the borehole to a depth of 280 feet bgs and the borehole extended 40 to 50 feet beyond the casing. This 10-inch well was originally planned for potable water supply, but was never completed as such. An agreement was made between the developer and the City of St. Marys to provide water and sewer service to the subdivision. The well was abandoned by capping the steel casing. Sometime later, a paving contractor tapped the steel casing with a 2-inch hand valve and installed a 2-inch PVC pipe connecting the well to the lake. It was reported that this well was artesian and would be used to sustain the lake during droughts. During this evaluation a site visit to the well was conducted and the valve opened. There was no indication of water flow from the well.

The second well is 4 inches in diameter and is located in the yard of Lot No. 1 on Plantation Drive at the intersection of Plantation Drive and Spur 40. The well was reportedly installed by a drilling company that reportedly went out of business approximately five years ago. Attempts to locate former employees were unsuccessful. Reportedly, this 4-inch well is artesian and was installed about two years ago. It was also intended to sustain Porcupine Lake during droughts. The depth of the well is unknown, but is estimated to range from 600 to 700 feet bgs. The well is constructed of 4-inch steel casing. The steel casing extends aboveground to a 4-inch gate valve. PVC pipe, 4 inches in diameter, extends from the gate valve to the lake. There is no indication this well has been used.

Detailed knowledge of well and piping construction for the two deep wells are lacking. The potential for backflow from Porcupine Lake to the wells cannot be fully evaluated. It is unlikely that the PVC piping leading to the lake was laid on grade. Based on current knowledge, backflow would not occur unless valves at the wells were opened, the pipes filled with groundwater and flow then reversed to create a siphon effect.

There is a 6-foot by 6-foot enclosed pump house on the northern edge of the lake. The enclosed pump is not connected to either of the wells discussed in this subsection. The pump draws water from the lake and pumps it to a fountain in the middle of the lake. The fountain has not been observed in use by residents of Crooked River Plantation Subdivision for several years.

**4.3.2 Status of Contamination** Physical data collected at each surface water sampling location included measurements of pH, specific conductance, temperature, and depth of water. Porcupine Lake is deeper at the west end (6.32 feet) and east end (5.32 feet) than in the center (4.90 feet). The water in the lake is clear and supports abundant flora and fauna. Aquatic plants, perch, and bass were observed by investigative team field crew members. The pH measurements indicate the water is neutral, ranging from 6.61 s.u. at sample location SW103 to 7.10 s.u. at location SW105. Specific conductance ranged from 254  $\mu$ mhos/cm at location SW103 to 272  $\mu$ mhos/cm at location SW105. Specific conductance of the lake water is moderately low, based on comparison to a range of less than 1  $\mu$ mhos/cm typical of distilled water to approximately 50,000  $\mu$ mhos/cm for sea water. Temperature of the lake water ranged from 22.8°C at location SW104 to 24.1°C at location SW105.

No VOCs were detected during on-site VOC analysis of the sediment and surface water samples collected from Porcupine Lake. Tables 4-1 and 4-2 summarize on-

site and off-site laboratory analytical data, respectively, for surface water and sediment samples from Porcupine Lake. Samples were analyzed for TCL VOCs and SVOCs by the off-site laboratory. The only VOCs detected during off-site laboratory analysis of surface water or sediment samples were 2-butanone and acetone in sample SW103 and carbon disulfide in all three sediment samples. Acetone and 2-butanone were detected at concentrations of 2 J  $\mu\text{g/l}$  and 4 J  $\mu\text{g/l}$ , respectively. The 2-butanone concentration is considered estimated (flagged J) because it is below the reporting limit of 5  $\mu\text{g/l}$ . Also, the acetone concentration of 2 J  $\mu\text{g/l}$  is below the MDL of 3.491  $\mu\text{g/l}$  (Table 3-5). While the detection of acetone below the MDL is positive evidence for the presence of acetone, measurement at this concentration is considered an estimate. Carbon disulfide in sediment samples is attributed to natural biogenic processes.

2-Butanone was not detected in any QC samples associated with this investigation, but it is a chemical commonly found in laboratory samples and as a result of many man-made and natural processes.

No SVOCs were detected in surface water samples from Porcupine Lake. Two phthalate compounds, bis(2-ethylhexyl)phthalate and di-n-butylphthalate, were detected in sediment samples from the lake. Concentrations of these compounds ranged from 47 J  $\mu\text{g/kg}$  to 400 J  $\mu\text{g/kg}$ . QC blanks associated with the sediment samples did not contain concentrations of these phthalate compounds. Phthalates are commonly laboratory and/or sampling artifact chemicals. Phthalates can be introduced into sample media through sample gloves, sample containers, tubing, and plastic material used during sample collection and analysis. Bis(2-ethylhexyl)phthalate was detected in method blanks associated with other samples from this investigation at concentrations ranging from 1 J  $\mu\text{g/l}$  to 35  $\mu\text{g/l}$ . This suggests that the concentrations of bis(2-ethylhexyl)phthalate may be wholly or partly attributed to laboratory artifacts. Phthalates are generally ubiquitous in the environment and the concentrations detected in the sediment samples could be the result of human activity. It is unlikely that phthalates would migrate from the landfill in groundwater because they have low water solubility and high octanol carbon partitioning coefficients. For these reasons, phthalates tend to adsorb to particulates and no real groundwater transport occurs.

**4.4 AIR SCREENING SURVEY.** Data collected during the air screening survey are presented in Appendix F. None of the air screening measurements taken from locations in Crooked River Plantation Subdivision were above the range of background readings. Background concentrations of vinyl chloride ranged from 0.20 to 2.20 ppm. This range of vinyl chloride seems high because the background readings reflect the total concentration of all compounds present having wavelengths similar to vinyl chloride. The headspace of one monitoring well at the landfill (KBA-11-2) contained vinyl chloride at a concentration of 5.86 ppm, based on air survey screening data. This concentration exceeds the range of background concentrations. This reading could be influenced by the presence of other compounds having a similar wavelength to vinyl chloride when measured by infrared spectroscopy. Figure 2-6 shows the locations where air survey screening measurements were collected.

Table 4-1 Summary of On-site Laboratory Analysis of Surface Water and Sediment Samples

Compound	Surface Water Sampling Locations (µg/l)					
	SW101	SW102	SW103	SW104	SW104D	SW105
Vinyl chloride	2 U	2 U	2 UJ	2 UJ	2 UJ	2 UJ
trans-1,2-Dichlorethene	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	5 U	5 U	5 U	5 U	5 U	5 U

Compound	Sediment Sampling Locations (µg/kg)			
	SD101	SD102	SD102D	SD103
Vinyl chloride	2 U	2 U	2 U	2 U
trans-1,2-Dichlorethene	5 UJ	5 UJ	5 UJ	5 UJ
cis-1,2-Dichloroethene	5 U	5 U	5 U	5 U
Trichloroethene	5 U	5 U	5 U	5 U
Tetrachloroethene	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U
Toluene	5 U	5 U	5 U	5 U
Ethylbenzene	5 U	5 U	5 U	5 U
m/p-Xylene	10 U	10 U	10 U	10 U
o-Xylene	5 U	5 U	5 U	5 U

Notes:

U = compound was not detected at the stated concentration

J = quantitation limit is considered estimated because a continuing calibration standard exceeded QC limits

µg/l = micrograms per liter

µg/kg = micrograms per kilogram

Table 4-2 Summary of Off-Site Laboratory Analysis of Surface water and Sediment Samples

Compounds Detected	Surface Water Sampling Locations ( $\mu\text{g/l}$ )				Sediment Sampling Locations ( $\mu\text{g/kg}$ )			
	11SW103	11SW104	11SW104D	11SW105	11SD101	11SD102	11SD102D	11SD103
<b>Volatile Organic Compounds</b>								
2-Butanone <sup>1,2</sup>	2 J	5 U	5 U	5 U	13 U	14 U	13 U	14 U
Acetone <sup>2</sup>	4 J	5 U	5 U	5 U	13 U	14 U	13 U	14 U
Carbon Disulfide <sup>1</sup>	1 U	1 U	1 U	1 U	13 U	4 J	2 J	27
<b>Semivolatile Organic Compounds</b>								
bis(2-Ethylhexyl)phthalate <sup>2</sup>	10 U	10 U	10 U	10 U	420 U	47 J	420 U	460 U
Di-n-butylphthalate <sup>2</sup>	10 U	10 U	10 U	10 U	120 J	400 J	330 J	290 J

Notes: U = compound was not detected at the stated concentration

J = sample result is considered estimated because the concentration is less than the Sample Quantitation Limit

SW = surface water sample

SD = sediment sample

$\mu\text{g/l}$  = micrograms per liter

$\mu\text{g/kg}$  = micrograms per kilogram

<sup>1</sup> = sample result is considered estimated and flagged with a J qualifier because an associated continuing calibration standard exceeded QC limits.

<sup>2</sup> = sample results are considered estimated and flagged with a J qualifier because concentrations are less than the Sample Quantitation Limit.

Interpretation of the air screening survey data is limited by the direct reading instrumentation's detection limits. No emissions "hot spots" were identified during the survey. However, the instrumentation's detection limits are generally an order of magnitude greater than the concentrations of vinyl chloride detected in groundwater samples from the Crooked River Plantation Subdivision. An air monitoring program will be developed for the Supplemental RFI to increase the levels of certainty associated with evaluation of the potential for emissions of VOCs from soil.

Two preliminary surface water samples were collected from Porcupine Lake and analyzed in the on-site laboratory. No target VOCs were detected. These data were used to establish a need for air flux sampling in the area of the lake. Because no VOCs were detected in the two preliminary surface water samples, no air flux samples were collected.

**4.5 SOIL VAPOR SAMPLING.** Soil gas samples collected using the vapor cone were analyzed in the on-site laboratory for target VOCs. Of the 22 samples collected and analyzed, two contained detectable concentrations of target VOCs (Table 4-3). These two samples are in the east-central area of the landfill (see Figure 2-3). Sample V106 contained 5.9  $\mu\text{g/l}$  of vinyl chloride. Sample V107 contained ethylbenzene at a concentration of 5.6  $\mu\text{g/l}$  and xylenes (total) at a concentration of 12.8  $\mu\text{g/l}$ . Three additional samples, V120, V121, and V122, were collected to assess the extent of VOCs in soil vapor in this area. No target VOCs were detected in the three additional soil gas samples. The presence of VOCs in soil gas samples V106 and V107 is attributed to the proximity of source material and is limited to this isolated area in landfill.

Four soil gas samples (V116 through V119) were collected from locations adjacent to monitoring well KBA-11-2. This monitoring well is located in an area where relatively high concentrations of VOCs, vinyl chloride in particular, were detected in groundwater samples collected during the August 1992 investigation. The VOCs in this area are also present at shallow depths compared to other areas of the plume. The absence of detectable concentrations of VOCs in the four soil gas samples indicates that there is little or no potential for accumulation of VOCs in the unsaturated soils overlying the groundwater contamination.

**4.6 ON-SITE GROUNDWATER CONTAMINATION.** A total of 70 groundwater samples, including nine duplicate samples, were collected from the 24 locations around the perimeter and one location in the landfill. Figure 2-2 shows locations where hydrocone groundwater samples were collected. Analytical data from on-site analyses are presented in Table 4-4. Eight groundwater samples, including one duplicate sample, from on-site locations were submitted for off-site laboratory analysis. Validated analytical data from off-site analysis are presented in Table 4-5.

Three of eight groundwater samples analyzed in the off-site laboratory were analyzed for SVOCs, only.

The on-site analytical data for eight groundwater samples collected from three locations (H123, H124, and H143) to the east and upgradient of the landfill do not indicate the presence of VOCs. Sample depths ranged from 9 to 54 feet bgs. These data indicate target VOCs are not migrating from a source upgradient of

Table 4-3 Summary of On-site Laboratory Analysis of Vapor Cone Soil Gas Samples

Compound	Vapor Cone Sampling Locations (µg/l)											
	V101	V102	V103	V104	V105	V106	V107	V108	V109	V110	V111	V112
Vinyl chloride	2 UJ	2 U	2 UJ	2 U	2 UJ	5.9	2 UJ	2 U	2 UJ	2 U	2 UJ	2 U
trans-1,2-Dichloroethene	5 U	5 UJ	5 U	5 UJ	5 U	5 UJ	5 U	5 UJ	5 U	5 UJ	5 U	5 UJ
cis-1,2-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U	5.6	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	10 UJ	10 U	10 UJ	10 U	10 UJ	10 U	5.8 J	10 U	10 UJ	10 U	10 UJ	10 U
o-Xylene	5 U	5 U	5 U	5 U	5 U	5 U	7.0	5 U	5 U	5 U	5 U	5 U

Compound	Vapor Cone Sampling Locations (µg/l)											
	V113	V114	V115	V116	V117	V118	V119	V120	V120D	V121	V122	V122D
Vinyl chloride	2 UJ	2 UJ	2 UJ	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
trans-1,2-Dichloroethene	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	10 UJ	10 U	10 UJ	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

## Notes:

U = compound was not detected at the stated concentration

J = quantitation limit is considered estimated because a continuing calibration standard exceeded QC limits

µg/l = micrograms per liter

Table 4-4 On-site Analytical Data for Hydrocone Groundwater Samples

Compound	Sample ID Numbers (µg/l)										
	MCL	H10109	H10116	H10121	H10210	H10216	H10225	H10220	H10320D	H10330	H10342
Vinyl chloride	2	2 U	2 U	220 J	2 U	2 U	7.8	2 U	2 U	2 U	2 U
trans-1,2-dichloroethene	100	5 U	5 U	6.4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 U	5 U	64 J	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	51 J	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	700	5 U	5 U	200 J	5 U	18	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	94 J	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	49	5 U	5 U	5 U	5 U	5 U	5 U	5 U

Compound	Sample ID Numbers (µg/l)										
	MCL	H10407	H10414	H10422	H10430	H10505	H10507	H10530	H10545	H10559	H10559D
Vinyl chloride	2	2 U	2.5	2 U	19	2 U	2 U	2 U	20 U	2 U	2 U
trans-1,2-Dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U	5 U	5 U
cis-1,2-Dichloroethene	70	5 U	5 U	5 U	98 J	5 U	5 U	5 U	50 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U	5 U	5 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5.1	5 U	5 U	5 U	50 U	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	12	5 U	5 U	5 U	50 U	5 U	5 U
Ethylbenzene	700	5 U	5 U	5 U	8.2	5 U	5 U	5 U	50 U	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	14	10 U	10 U	10 U	110	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	6.9	5 U	5 U	5 U	50 U	5 U	5 U

See notes at end of table.

Table 4-4 (continued) On-site Analytical Data for Hydrocone Groundwater Samples

Compound	Sample ID Numbers (µg/l)													
	MCL	H10622	H10632	H10642	H10647	H10726	H10728	H10728 D	H10736	H10756	H10822	H10832	H10832D	H10841
Vinyl chloride	2	12	26	32	15	15	13	14	36	2 U	2.7	10	10	31
trans-1,2-dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 U	5 U	22	9.8	6.2	12	12	5 U	5 U	5 U	5 U	5 U	7.9
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5.1	5.0	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	22	10	5 U	5 U	5 U	52 J	5 U	5 U	5 U	5 U	30
Ethylbenzene	700	26	18	5 U	5 U	5 U	18	19	5 U	5 U	5 U	5 U	5 U	13
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

Compound	Sample ID Numbers (µg/l)										
	MCL	H10923	H10923D	H10937	H10949	H10949D	H11014	H11024	H11026	H11039	H11050
Vinyl chloride	2	4.1	3.2	90 J	17	18	2 U	2 U	2 U	2 U	2 U
trans-1,2-Dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 U	5 U	5 U	12	10	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	7.8	8.3	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	6.9	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	190 J	24	22	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	700	8.1	8.0	52 J	7.4	6.5	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	100 J	10	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	55 J	5 U	5.6	5 U	5 U	5 U	5 U	5 U

See notes at end of table.

Table 4-4 (continued) On-site Analytical Data for Hydrocone Groundwater Samples

Compound	MCL	Sample ID Numbers (µg/l)							
		H11117	H11134	H11160	H11215	H11232	H11241	H11325	H11311
Vinyl chloride	2	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 UJ
trans-1,2-dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ
cis-1,2-dichloroethene	70	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ
Toluene	1,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ
Ethylbenzene	700	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 UJ
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ

Compound	MCL	Sample ID Numbers (µg/l)									
		H11346	H11346D	H11415	H11442	H11549	H11559	H11625	H11635	H11644	H11726
Vinyl chloride	2	2.0	2.8	2 U	2 UJ	2 U	2 U	300 J	16	22	31 J
trans-1,2-Dichlorethene	100	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	15	5 UJ
cis-1,2-dichloroethene	70	5 U	5 U	5 U	5 UJ	5 U	5 U	250 J	37	10 U	5 UJ
Trichloroethene	5	5 U	5 U	5 U	5 UJ	5 U	5 U	45	5 U	10 U	5 UJ
Tetrachloroethene	5	5 U	5 U	5 U	5 UJ	5 U	5 U	5.6	5 U	10 U	5 U
Benzene	5	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5.0	5 UJ
Toluene	1,000	5 U	5 U	5 U	5 UJ	5 U	5 U	21 J	430 J	140 J	5 UJ
Ethylbenzene	700	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	38	12	50 J
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	10 UJ	10 U	10 U	10 U	57	22	10 UJ
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	30	14	5 UJ

See notes at end of table.

Table 4-4 (continued) On-site Analytical Data for Hydrocone Groundwater Samples

Compound	MCL	Sample ID Numbers (µg/l)								
		H11744	H11756	H11768	H11816	H11816D	H11826	H11835	H11845	H11855
Vinyl chloride	2	17 J	13 J	2 UJ	NEG	NEG	POS	NEG	POS	NEG
trans-1,2-dichloroethene	100	5 UJ	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Trichloroethene	5	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 UJ	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 UJ	26 J	5 UJ	5 U	5 U	5 U	78 J	5 U	5 U
Ethylbenzene	700	16 J	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 UJ	10 UJ	10 UJ	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 UJ	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U

Compound	MCL	Sample ID Numbers (µg/l)										
		H11940	H11950	H12015	H12035	H12045	H12045D	H12055	H12072	H12126	H12144	H12153
Vinyl chloride	2	POS	POS	POS	POS	POS	POS	NEG	POS	NEG	2 UJ	2 UJ
trans-1,2-Dichloroethene	100	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U	5 U
cis-1,2-dichloroethene	70	21 J	16 J	5 UJ	8.6 J	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
Trichloroethene	5	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
tetrachloroethene	5	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
Benzene	5	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	140 J	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	700	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U

See notes at end of table.

Table 4-4 (continued) On-site Analytical Data for Hydrocone Groundwater Samples

Compound	Sample ID Numbers (µg/l)										
	MCL	H12211	H12236	H12236D	H12243	H12253	H12261	H12271	H12309	H123226	H12430
Vinyl chloride	2	2 UJ	15 J	15 J	3.7 J	4.3 J	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ
trans-1,2-dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 U	6.3	6.5	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	6.2	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	700	5.2	20	20	16	5.3	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

Compound	Sample ID Numbers (µg/l)									
	MCL	H12445	H12453	H12523	H12535	H12535D	H12553	H12612	H12634	H12650
Vinyl chloride	2	2 UJ	2 UJ	2 U	9.6 J	7.0 J	2 U	2 UJ	2.6 J	2 UJ
trans-1,2-Dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 U	5 U	5 U	5 UJ	5 UJ	5 U	5 UJ	5 UJ	5 UJ
Trichloroethene	5	5 U	5 U	5 U	5 UJ	5 UJ	5 U	5 UJ	5 UJ	5 UJ
Tetrachloroethene	5	5 U	5 U	5 U	5 UJ	5 UJ	5 U	5 UJ	5 UJ	5 UJ
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	12	12	5 U	5 U	5 U	5 U
Ethylbenzene	700	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

See notes at end of table.

Table 4-4 (continued) On-site Analytical Data for Hydrocone Groundwater Samples

Compound	Sample ID Numbers (µg/l)										
	MCL	H12716	H12716D	H12729	H12740	H12747	H12748	H12762	H12811	H12837	H12853
Vinyl chloride	2	14 J	16 J	27 J	15 J	7.2 J	8.8 J	2 UJ	2 UJ	2 UJ	2 UJ
trans-1,2-dichloroethene	100	5 U	5 U	13	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	64 J	57 J	120 J	9.9 J	41 J	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	250 J	48 J	40 J	5 U	5 U	5 U	5 U
Ethylbenzene	700	5 U	5 U	5 U	23	5.8	5.7	5 U	5 U	5 U	5 U
m/p-Xylene	110,000	10 U	10 U	10 U	45	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	110,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

Compound	Sample ID Numbers (µg/l)										
	MCL	H12925	H12935	H12947	H12955	H13038	H13049	H13124	H13135	H13135D	H13147
Vinyl chloride	2	2.1	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	8.6 J	12 J	6.6 J	19 J
trans-1,2-Dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6.1	6.6	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	28	28	18
Ethylbenzene	700	5 U	5 U	5 U	5 U	5 U	5 U	6.3	8.0	7.8	5 U
m/p-Xylene	110,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	110,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

See notes at end of table.

Table 4-4 (continued) On-site Analytical Data for Hydrocone Groundwater Samples

Compound	Sample ID Numbers (µg/l)												
	MCL	H13157	H13166	H13220	H13322	H13331	H13340	H13356	H13435	H13555	H13628	H13642	H136420
Vinyl chloride	2	3.6 J	2 UJ	34 J	28 J	23 J	17 J	2 U	2 UJ	2 UJ	23	10	13
trans-1,2-dichloroethene	100	5 U	5 U	5 U	5 U	6.6	5 U	5 U	5 UJ	5 UJ	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 U	5 U	38 J	5.2	5.3	8.7	5 U	5 U	5 U	9.6	22	32 J
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	21	31 J
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	16	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	5 U	20	5 U	5 U	5 U	5 U	270 J	31 J	33 J
Ethylbenzene	700	5 U	5 U	5 U	5.9	5 U	40	5 U	5 U	5 U	22	6.2	6.4
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	10 U	43	10 U	10 U	10 U	10 U	52 J	10 UJ	10 UJ
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	5 U	19	5 U	5 U	5 U	5 U	30	6	6.3

Compound	Sample ID Numbers (µg/l)											
	MCL	H13646	H13726	H13827	H13842	H13863	H13935	H13940	H139400	H14030	H14035	H14052
Vinyl chloride	2	2 U	2 U	190 J	25	2 U	5.5	2 U	2 U	2 UJ	2 UJ	2 UJ
trans-1,2-Dichloroethene	100	5 U	5 U	5.0	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 U	5 U	140 J	21	5 U	5 U	9.6	9.1	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ
Toluene	1,000	6.8	5 U	140 J	32 J	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ
Ethylbenzene	700	5 U	5 U	30	42 J	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ
m/p-Xylene	<sup>1</sup> 10,000	10 UJ	10 U	53	63 J	10 U	10 U	10 U	10 U	10 UJ	10 UJ	10 UJ
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	32 J	28	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ

See notes at end of table.

Table 4-4 (continued) On-site Analytical Data for Hydrocone Groundwater Samples

Compound	MCL	Sample ID Numbers (µg/l)									
		H14134	H14138	H14220	H14229	H14245	H14333	H14342	H14342D	H14430	H14446
Vinyl chloride	2	16 J	15	2 U	2 U	2 U	2 U	2 U	2 U	45 J	6.2
trans-1,2-dichloroethene	100	5 U	21 J	5 U	5 UJ	5 UJ	5 U	5 U	5 U	5 U	13 J
cis-1,2-dichloroethene	70	17	5 UJ	5 U	5 UJ	5 UJ	5 U	5 U	5 U	15	5 UJ
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	5 U	5 U	5 UJ	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 U
Benzene	5	6.2 J	5 UJ	5 U	5 UJ	5 UJ	5 U	5 U	5 U	8.7	5 UJ
Toluene	1,000	5 UJ	200 J	5 U	5 UJ	5 UJ	5 U	5 U	5 U	5 U	18 J
Ethylbenzene	700	10 J	5 UJ	5 U	5 UJ	5 UJ	5 U	5 U	5 U	18	5 UJ
m/p-Xylene	<sup>1</sup> 10,000	10 UJ	10 UJ	10 U	10 UJ	10 UJ	10 U	10 U	10 U	18	10 UJ
o-Xylene	<sup>1</sup> 10,000	5 UJ	9.6 J	5 U	5 UJ	5 UJ	5 U	5 U	5 U	14	5 UJ

Compound	MCL	Sample ID Numbers (µg/l)			
		14547	H14547D	H14621	H14631
Vinyl chloride	2	31 J	33 J	54 J	120 J
trans-1,2-Dichloroethene	100	5 U	5 U	5 UJ	10 J
cis-1,2-dichloroethene	70	5 U	5 U	28 J	140 J
Trichloroethene	5	5 U	5 U	5 U	27
Tetrachloroethene	5	5 UJ	5 UJ	5 U	5 U
Benzene	5	5 U	5 U	5 UJ	5 U
Toluene	1,000	5 U	5 U	23 J	560 J
Ethylbenzene	700	5 U	5 U	40 J	10
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	41 J	23
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	28 J	12

Notes: <sup>1</sup> = total xylenes

J = sample result is considered estimated because continuing calibration exceeded QC limits or because concentration exceeded the linear range of the GC

POS = compound was detected but the concentration could not be quantified U = compound was not detected at the stated concentration

NEG = compound was not detected but a quantitation limit could not be calculated

MCL = Maximum Contaminant Level, USEPA Office of Water, December 1992; The Bureau of National Affairs, Inc., July 1992.

Table 4-5 Summary of Off-site Laboratory Analysis of Hydrocone Samples

Compound	Hydrocone Sampling Locations (µg/l)								
	MCL	H10116	H10342	1H10632	H111134	H11346	H11625	H11625D	H11835
Acetone <sup>1</sup>	NA	170	170	14 U	58	28	10 U	10 U	330 J
2-Butanone	NA	5 U	5 U	5 U	5 U	5 U	10 U	10 U	580
2-Hexanone	NA	5 U	5 U	5 U	5 U	5 U	10 U	10 U	18
4-Methyl-2-pentanone	NA	5 U	5 U	5 U	5 U	5 U	10 U	10 U	78
Carbon disulfide	NA	1	1 U	39 U	1 U	1 U	2 U	2 U	2 U
1,1-Dichloroethane	NA	1 U	1 U	1 U	1 U	1 U	2 U	2 U	3
1,2-Dichloroethane	5	1 U	1 U	1 U	1 U	1 U	9	9	1 U
1,2-Dichloropropane	5	1 U	1 U	1 U	1 U	1 U	2 U	2 U	1
Vinyl chloride	2	1 U	1 U	1 U	1 U	1 U	310	280	1 U
Trichloroethene	5	1 U	1 U	1 U	1 U	1 U	28	26	1 U
Tetrachloroethene	5	1 U	1 U	1 U	1 U	1 U	3	3	1 U
cis-1,2-dichloroethene	70	1 U	1 U	16	1 U	1 U	3600	3400	45
trans-1,2-dichloroethene	100	1 U	1 U	1 U	1 U	1 U	23	23	1 U
Benzene	5	1 U	1 U	5	1 U	1 U	2	3	4
Ethylbenzene	700	2	1 U	17	1 U	1 U	2 U	2 U	2
Chlorobenzene	100	10	1 U	1 U	1 U	1 U	2 U	2 U	2 U
1,4-Dichlorobenzene	75	12	1 U	1 U	1 U	1 U	2 U	2 U	2 U
Toluene	1,000	1 U	1 U	1 U	1 U	1 U	20	19	120
Xylenes (total)	10,000	1 U	1 U	1	1 U	1 U	2 U	2 U	4
<b>Semivolatile Organic Compounds</b>									
2,4-Dimethylphenol		---	---	---	---	---	---	---	---
2-Methylphenol		---	---	---	---	---	---	---	---
4-Methylphenol		---	---	---	---	---	---	---	---
Diethylphthalate		---	---	---	---	---	---	---	---
Napthalene		---	---	---	---	---	---	---	---

See notes at end of table.

Table 4-5 (continued) Summary of Off-site Laboratory Analysis of Hydrocone Samples

Compound	Hydrocone Sampling Locations (µg/l)									
	MCL	H11950	H12015	H12045	H12716	H12740	H12748	H12748D	H12811	H13642
Acetone <sup>1</sup>	NA	38 U	40 U	54 U	13 U	93	160	170	8 U	100 J
2-Butanone	NA	5 U	5 U	24	5 U	150	360	350	5 U	130
2-Hexanone	NA	5 U	5 U	5 U	5 U	70	19	16	5 U	1 U
4-Methyl-2-pentanone	NA	12	5 U	55	5 U	34	110	110	5 U	36
Carbon disulfide	NA	1 U	5 U	1 U	1 U	7	5	13	1 U	1 U
1,1-Dichloroethane	NA	1 U	2	1 U	1 U	24	5	5	1 U	12
1,2-Dichloroethane	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	5	1 U	1 U	1 U	1 U	6	1 U	1 U	1 U	1 U
Vinyl chloride	2	1 U	1 U	1 U	12	1 U	1 U	1 U	1 U	2
Trichloroethene	5	1 U	1 U	1 U	1 U	4	1 U	1 U	1 U	45
Tetrachloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-dichloroethene	70	21	1	1 U	82	18	1 U	1 U	1 U	50
trans-1,2-dichloroethene	100	1 U	1 U	1 U	1	1 U	1 U	1 U	1 U	1 U
Benzene	5	1 U	2	1 U	1 U	3	1 U	1 U	1 U	1 U
Ethylbenzene	700	1 U	1 U	1 U	1 U	41	7	6	1 U	9
Chlorobenzene	100	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	75	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1,000	1 U	1 U	4 U	1 U	580	68	65	1 U	61
Xylenes (total)	10,000	1 U	1 U	1 U	1 U	120	13	12	1 U	25
<b>Semivolatile Organic Compounds</b>										
2,4-Dimethylphenol		---	---	---	---	---	---	---	---	---
2-Methylphenol <sup>2</sup>		---	---	---	---	---	---	---	---	---
4-Methylphenol		---	---	---	---	---	---	---	---	---
Diethylphthalate		---	---	---	---	---	---	---	---	---
Napthalene		---	---	---	---	---	---	---	---	---

See notes at end of table.

Table 4-5 (continued) Summary of Off-site Laboratory Analysis of Hydrocone Samples

Compound	Hydrocone Sampling Locations (µg/l)					
	MCL	H13646	H14229	H138272	H146214	H14621D
Acetone <sup>1</sup>	NA	24 U	6	---	---	---
2-Butanone	NA	5 U	1 U	---	---	---
2-Hexanone	NA	5 U	1 U	---	---	---
4-Methyl-2-pentanone	NA	5 U	1 U	---	---	---
Carbon disulfide	NA	2 U	1 U	---	---	---
1,1-Dichloroethane	NA	1 U	1 U	---	---	---
1,2-Dichloroethane	5	1 U	1 U	---	---	---
1,2-Dichloropropane	5	1 U	1 U	---	---	---
Vinyl chloride	2	1 U	1 U	---	---	---
Trichloroethene	5	1 U	1 U	---	---	---
Tetrachloroethene	5	1 U	1 U	---	---	---
cis-1,2-dichloroethene	70	1 U	1 U	---	---	---
trans-1,2-dichloroethene	100	1 U	1 U	---	---	---
Benzene	5	1 U	1 U	---	---	---
Ethylbenzene	700	1 U	1 U	---	---	---
Chlorobenzene	100	1 U	1 U	---	---	---
1,4-Dichlorobenzene	75	1 U	1 U	---	---	---
Toluene	1,000	1 U	1 U	---	---	---
Xylenes (total)	10,000	1 U	1 U	---	---	---
<b>Semivolatile Organic Compounds</b>						
2,4-Dimethylphenol	NA	---	---	280	10 U	10 U
2-Methylphenol	NA	---	---	7 J	10 U	10 U
4-Methylphenol	NA	---	---	120	10 U	10 U
Diethylphthalate	NA	---	---	50	2 J	2 J
Napthalene	NA	---	---	10 U	19	20

Notes: U = compound was not detected at the stated concentration NA = none applicable

--- = analysis was not requested or performed

MCL = Maximum Contaminant Level, USEPA Office of Water, December 1992; The Bureau of National Affairs, Inc., July 1992.

<sup>1</sup> = sample result is considered estimated and flagged with a J qualifier because an associated continuing calibration standard exceeded QC limits.

<sup>2</sup> = sample results are considered estimated and flagged with a J qualifier because concentrations are less than the Sample Quantitation Limit.

the landfill, and that the VOC contamination detected in and downgradient of the landfill is derived from waste disposed.

The southern extent of VOC contamination in the area of the landfill, based on-site analytical data, was defined by seven groundwater samples collected from four locations (H134, H135, H137, and H142). Sample depths ranged from 20 to 56 feet bgs. No target VOCs were detected in the seven samples. One sample from location H142 (29 to 30 ft bgs) was submitted for off-site confirmatory analysis. The Level D off-site data confirm the absence of target VOCs in the sample.

Target VOCs were detected along the northern boundary of the landfill in the same area as monitoring wells KBA-11-4, KBA-11-5, and KBA-11-6. These monitoring wells intercept the water table and they are 13 feet deep. VOCs were detected in hydrocone groundwater samples from locations H108, H144, and H145 at depths ranging from 22 ft to 48 ft bgs along the northern margin of the landfill. Concentrations of total target VOCs ranged 2.7 to 119  $\mu\text{g/l}$ . Vinyl chloride concentrations ranged from 2.7 to 45  $\mu\text{g/l}$ , based on on-site laboratory data. Cis-1,2-dichloroethene and fuel related VOCs were also detected. Five groundwater samples were collected from two locations (H114 and H140) approximately 100 feet northeast of monitoring well KBA-11-4. Sample depths ranged from 15 to 53 ft bgs. No target VOCs were detected in these five samples.

Figure 4-1 is a cross-section showing the distribution and concentration of total VOCs in groundwater along the western margin of the landfill. The cross-section is based on on-site laboratory GC data associated with the Phase I Interim Investigation and the Interim Corrective Measure Screening Investigation. Figure 2-2 shows the location of the cross-section line. Total VOC concentrations for target compounds detected in groundwater samples from locations along the western margin of the landfill ranged from 2.7 to 902  $\mu\text{g/l}$ . The data indicate that the maximum depth of contamination is in the area of the hydrocone location H117, where target VOCs were detected at a depth of 57 feet bgs. Based on the contours in Figure 4-1, the approximate maximum depth of contamination is 65 feet bgs. To the north and south of location H117, the base of the plume is estimated to be approximately 50 feet bgs. The minimum depth of VOC contamination in the area of the landfill is estimated to be approximately 10 to 20 feet bgs. Five VOCs were detected in hydrocone groundwater samples from the landfill area at concentrations above Federal Maximum Contaminant Levels (MCLs). The five VOCs are vinyl chloride, trichloroethene, cis-1,2-dichloroethene, tetrachloroethene, and benzene. MCLs are included on analytical data tables for on-site (Table 4-4) and off-site (Table 4-5) analyses. Of these five VOCs, vinyl chloride concentrations were above its MCL of 2  $\mu\text{g/l}$  more frequently than any other VOC. Vinyl chloride was detected at concentrations above its MCL at 14 of 24 locations sampled at the landfill.

Three groundwater samples, including one duplicate sample, were collected for analysis of TCL SVOCs in the off-site laboratory. SVOC data are presented in Table 4-4. These samples were collected from locations and depths within the contaminant plume to provide additional information about other organic compounds that may be associated with the plume and that are not present in samples from the monitoring wells at the site. Five SVOCs were detected, including three phenolic compounds (2,4-dimethylphenol, 2-methylphenol, and 4-methylphenol), diethylphthalate, and naphthalene, which is a fuel-related SVOC. The



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CROSS SECTION A-A'  
TOTAL TARGET VOCs  
ON-SITE ANALYTICAL DATA



NAVAL SUBMARINE BASE  
KINGS BAY, GEORGIA

concentrations of SVOCs range from 2 J  $\mu\text{g/l}$ , which is estimated because it is below the SQL, to 280  $\mu\text{g/l}$ . The phthalate compound detected in these samples could be sampling or laboratory artifact. Phthalates present in waste disposed would tend to adsorb to soil particles. The phenolic compounds detected may be the result of degradation of aromatic compounds or disposal of containers having residual amounts of disinfectant cleaners, pesticides, and/or herbicides. Fuel-related VOCs are characteristic of the plume; therefore, the presence of naphthalene is not unexpected.

Part of the RFI at Site 11 includes bimonthly groundwater monitoring. Results of the first five sampling events are presented in five technical memoranda (ABB-ES, 1992 d-g, 1993). Analytical data for the sixth, and last, sampling event were not available for use in this report. Table 4-6 summarizes VOC analytical data for five rounds of groundwater samples. Eleven VOCs have been detected in groundwater samples from monitoring well KBA-11-2. Groundwater samples from monitoring well KBA-11-2 have consistently contained vinyl chloride and 1,2-dichloroethene. For the most part, VOCs have not been detected consistently in samples from other monitoring wells. The exception being the presence of chlorobenzene and 1,4-dichlorobenzene in samples from monitoring well KBA-11-3 and 1,4-dichlorobenzene in samples from KBA-11-6. The VOC data associated with the Interim Corrective Measure Screening Investigation indicate that the majority of VOC contamination at the landfill is below the screened intervals of the monitoring wells, which are 3 to 13 feet bgs. Additional, deeper monitoring wells are needed at the landfill and will be installed during the Supplemental RFI. The existing monitoring wells should be used in conjunction with deeper monitoring wells for adequate monitoring of the surficial aquifer.

**4.7 OFF-SITE GROUNDWATER CONTAMINATION.** Groundwater samples were collected from 17 locations in Crooked River Plantation Subdivision and five locations along the western right-of-way to Spur 40. Ninety groundwater samples, including seven duplicate samples, were collected from 22 off-site sample locations. (See Figure 2-1). All samples were analyzed in the on-site laboratory. Fourteen samples were submitted to the off-site laboratory for confirmatory VOC analysis. Tables 4-4 and 4-5 contain laboratory data from the on-site and off-site analyses, respectively.

The approximate horizontal extent of VOC contamination at various depth intervals is shown in Figures 4-2, 4-3, and 4-4 and is based on on-site analytical data from the Phase I Interim Investigation and the Interim Corrective Measure Screening Investigation. The overall shape of the plume shown in Figures 4-2, 4-3, and 4-4 is computer generated using GIS/KEY™ in combination with QUICKSURF™. The area representing the plume is inferred from data associated with actual sample locations. At locations within the contoured areas of Figures 4-2, 4-3, and 4-4 and between sample locations, the actual presence of plume contaminants, and potential concentration of compounds, can only be determined by collection and analysis of groundwater samples. The plume plan view figures will be revised to include the landfill after data are collected from locations within the landfill. An addendum to this report is expected to follow the landfill investigation.

Table 4-6 Summary of VOC Analytical Data for RFI Groundwater Monitoring Program at Site 11

Monitoring Well I.D.	VOCs Detected	Concentration Range (µg/l)	Associated Sample Events
KBA-11-1	None		
KBA-11-2	vinyl chloride	18 -160	1,2,3,4,5
	1,2-dichloroethene	4.8 -22	1,2,3,4,5
	ethylbenzene	1 J	5
	toluene	1 J - 3 J	2,4,5
	xlenes (total)	2 J - 4 J	2,3,5
	1,4-dichlorobenzene	1 J	5
	chloroethane	3 J - 5 J	3,5
	chloromethane	3.3	4
	trichloroethene	1 J	2
	tetrachloroethene	1 J	2
	chloroform	4 J	1
KBA-11-3	chlorobenzene	3 J - 6	1,2,3,4,5
	1,4-dichlorobenzene	15 - 28	1,2,4,5
	1,3-dichlorobenzene	15	2,3
KBA-11-4	None		
KBA-11-5	xlenes (total)	2	1
	1,4-dichlorobenzene	1 J - 2 J	1,2,3,4
KBA-11-6	xlenes (total)	2	1
	1,4-dichlorobenzene	1 J - 2 J	1,2,3,4
KBA-11-7	None		
KBA-11-8	vinyl chloride	2 J	1
	ethylbenzene	1 J	1
	xlenes (total)	5	1
	chloroethane	2 J	2
KBA-11-9	xlenes	3 J	1

Notes: µg/l = micrograms per liter  
J = estimated concentration

Sources:

ABB-ES, 1992d.  
ABB-ES, 1992f.  
ABB-ES, 1993.

ABB-ES, 1992e.  
ABB-ES, 1992g.







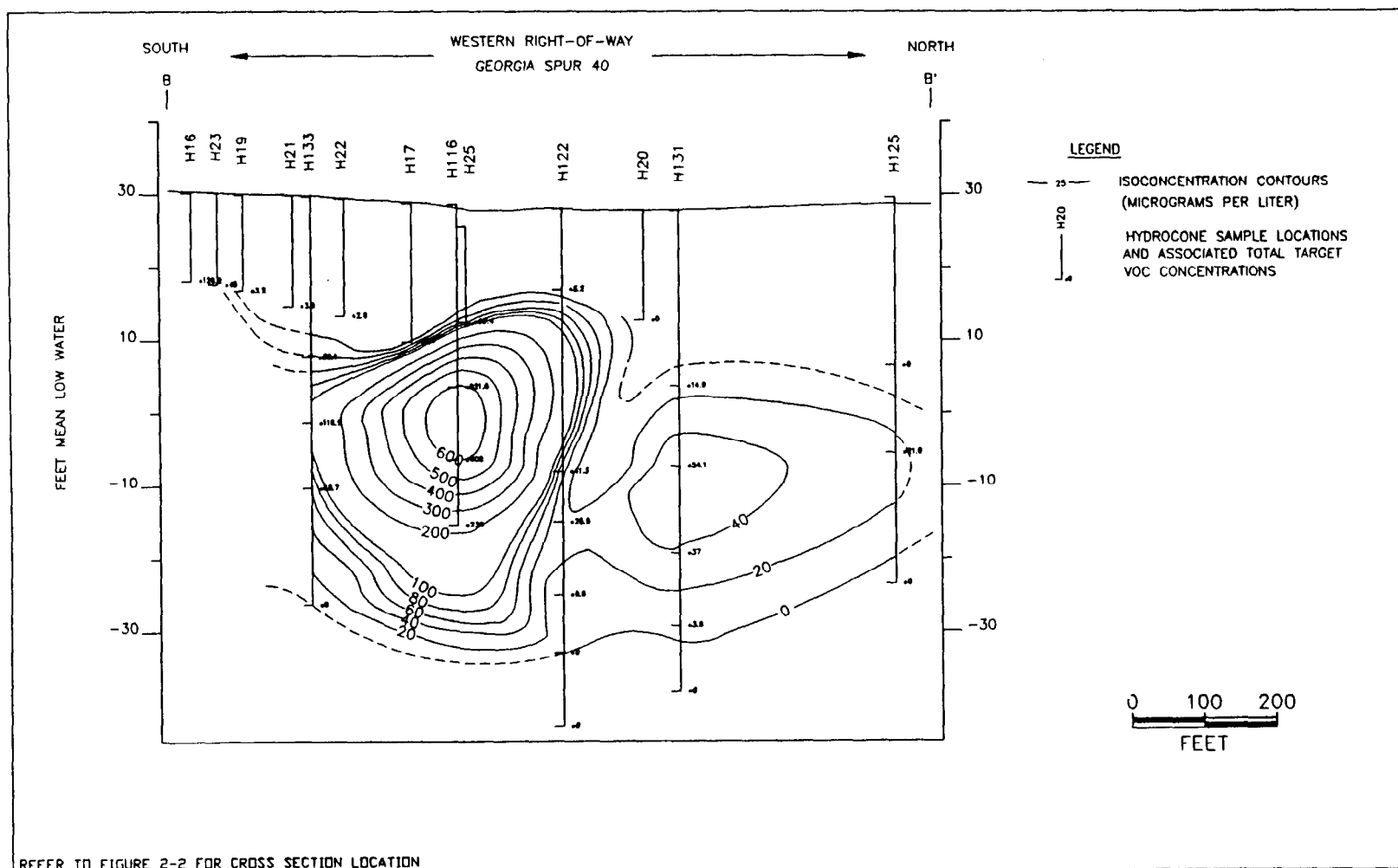
The analytical data collected to date indicate the plume extends approximately 600 feet to the west-northwest beyond the NSB property line. The on-site and Level D off-site analytical data indicate the plume has migrated into Crooked River Plantation Subdivision. Comparison of Figures 4-2, 4-3, and 4-4 indicates that the majority of groundwater VOC contamination is approximately 30 feet bgs, or near 0 feet MLW (Figure 4-3). The plume appears to have two lobes in Figures 4-2 and 4-3, where concentrations of total target VOCs exceed 500 µg/l. The base of the plume, shown in Figure 4-4, is rather narrow compared to shallower depths. The two lobes or "slugs" of contaminated groundwater are not expressed at the base of the plume.

VOCs detected in groundwater samples collected from locations along the western right-of-way to Spur 40 and in the Crooked River Plantation Subdivision include the same solvents and fuel related VOCs detected in samples from locations in and around the landfill. Figures 4-5 and 4-6 are cross-sections (B-B' and C-C') showing the distribution of total target VOCs on the western right-of-way to Spur 40 and in the Crooked River Plantation Subdivision, respectively. The cross-sections are based on on-site analytical screening data. The locations of the cross-sections are shown in Figure 2-2. Comparison of the two cross-sections indicated the plume is not as wide and generally has less magnitude in the subdivision than along the right-of-way. As migration continues, the configuration of the plume will change, as will the concentration of contaminants.

VOC contaminants were detected in groundwater samples from locations along the right-of-way to Spur 40 at depths ranging from 11 to 58 feet bgs. Based on the plume contours shown in Figure 4-5, the maximum depth of contamination on the right-of-way is approximately 60 feet bgs. In the subdivision, where VOCs were detected in groundwater samples from depths ranging from 14 to 51 feet bgs, Figure 4-6 indicated the base of the plume to be approximately 50 to 60 feet bgs. Along Plantation Court the top of the plume is approximately 30 feet bgs. To the north of Plantation Court, the top of the plume is approximately 10 feet bgs, based on the chemical contours in Figure 4-6.

Concentrations of total target VOCs in samples from the right-of-way of Spur 40 range from 5.2 to 622 µg/l, based on field GC analysis. Sample H11625 was submitted to the off-site laboratory and was reported to contain 3,995 µg/l total VOCs, primarily cis-1,2-dichloroethene. Excluding samples from location H116, the concentration of total VOCs ranged from 5.2 to 116 µg/l. In the subdivision, the concentration of total target VOCs ranges from 2.1 to 362 g/l. The off-site laboratory analytical data for sample H12740 indicate this sample contained a concentration of 1,150 µg/l of total VOCs. This sample contained 362 µg/l total target VOCs, based on field GC analysis. The toluene concentration in this sample exceeded the calibration range of the field GC in the on-site laboratory and the reported concentration was biased low. Excluding samples from location H127, total target VOCs ranged from 2.1 to 163 µg/l.

Off-site laboratory data indicate the presence of concentrations of ketones (2-butanone, 2-hexanone, and 4-methyl-2-pentanone) ranging from 12 to 580 µg/l that do not appear to be artifacts based on validation criteria and review of QC data. The source and relationship of these ketones to the landfill are uncertain. Ketones might be expected at the landfill because they can be in solvents and



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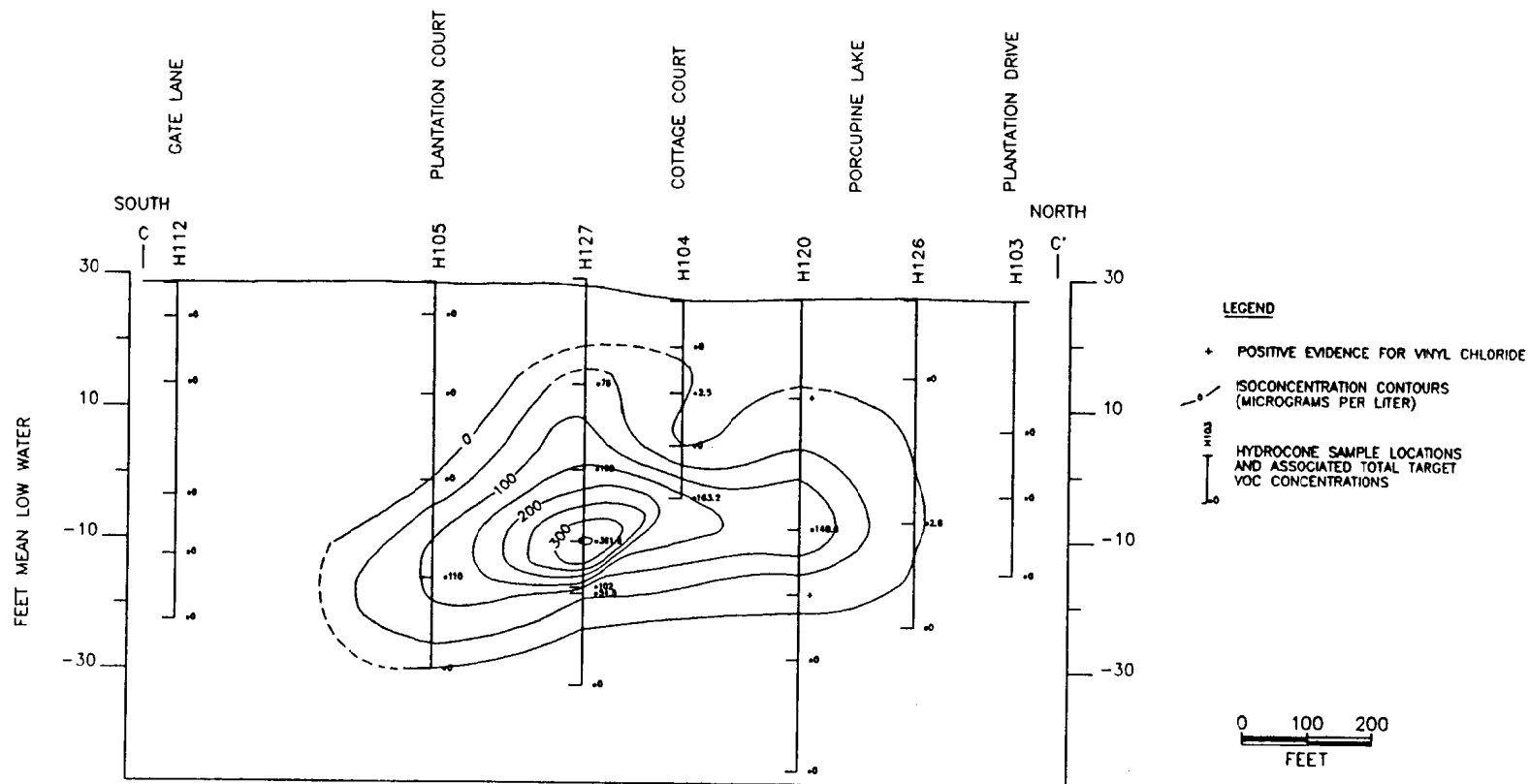
DWN:	DES.:	PROJECT NO.:	TITLE:
LGT	LGT	7553	
CHKD:	APPD:	FIGURE NO.:	
LBH	LBH	4-5	
DATE:	REV.:		
2/18/93			

CROSS SECTION B-B'  
TOTAL TARGET VOCs  
ON-SITE ANALYTICAL DATA




INTERIM CORRECTIVE MEASURE  
SCREENING INVESTIGATION  
REPORT

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KINGS BAY, GEORGIA



KINGSBAY\CHM\MAPS\CHS4-6.dwg

DWN: LGT	DES: LGT	PROJECT NO.: 7553	TITLE:  CROSS SECTION C-C' TOTAL TARGET VOCs ON-SITE ANALYTICAL DATA
CHKD: LBH	APPD: LBH	FIGURE NO.: 4-6	
DATE: 2/17/93	REV.:		



INTERIM CORRECTIVE MEASURE  
SCREENING INVESTIGATION  
REPORT

NAVAL SUBMARINE BASE  
KINGS BAY, GEORGIA

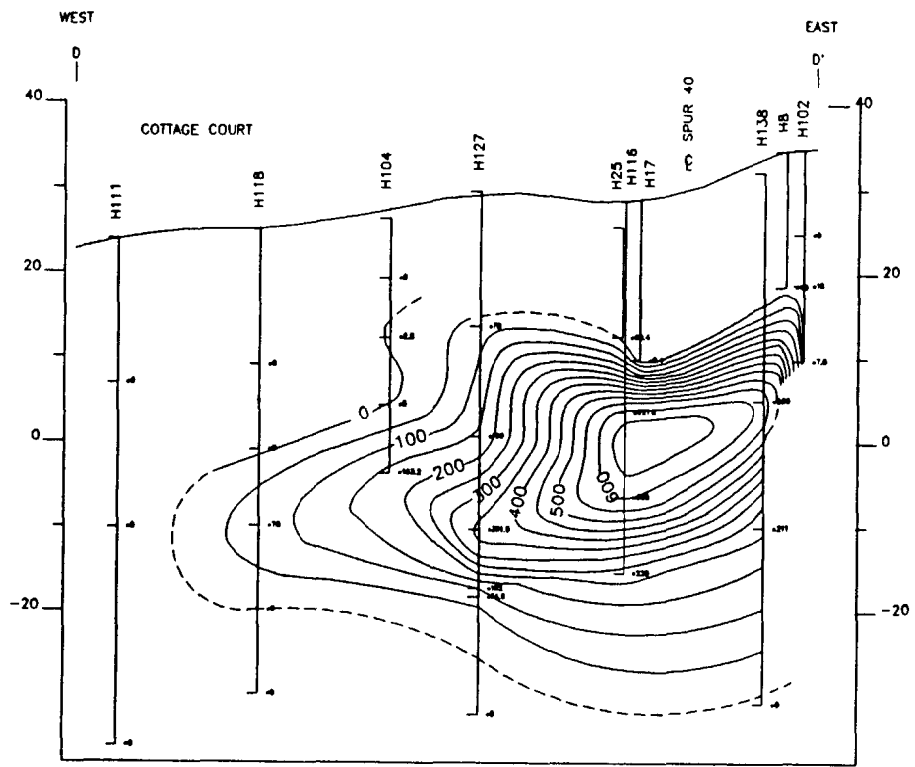
form degradation of plastic and microbial action on organic compounds, Additional information will be obtained during follow-on investigations so these compounds can be evaluated further.

Figures 4-7 and 4-8 are cross-sections (D-D' and E-E') of the plume that extend from the landfill into the subdivision. Locations of the cross-sections are shown in Figure 2-2. In Figure 4-8, the cross-section line extends to the west down Plantation Court, which is the southern part of the plume. VOCs were detected at depths ranging from 40 to 51 feet bgs at sample locations on Plantation Court. In the northern part of the plume, on Cottage Court, VOCs were detected at shallower depths ranging from 14 to 48 feet bgs (Figure 4-7). One sample from location H127 (40 to 41 feet bgs) contained a concentration of total VOCs of 796  $\mu\text{g/l}$  (off-site analysis). Comparison of Figures 4-7 and 4-8 indicates that the magnitude and extent of groundwater contamination is greater in the area of Cottage Court than Plantation Court.

In summary, results of the Interim Corrective Measure Screening Investigation indicate that VOCs have migrated approximately 600 feet west of the NSB property line. VOCs characteristic of groundwater in the area of the landfill were also detected in groundwater from certain hydrocone locations in Crooked River Plantation Subdivision and along the western right-of-way of Spur 40. VOCs were detected at depths ranging from 40 to 51 feet bgs on Plantation Court, which is the southern part of the plume, and 14 to 48 feet bgs on Cottage Court, which is the northern part of the plume. On the right-of-way to Spur 40, VOCs were detected at depths ranging from 11 to 58 feet bgs. Chemical isoconcentration contour maps indicate the base of the plume is 50 to 60 feet bgs. Seven VOCs were detected in groundwater samples from locations on the right-of-way and in the subdivision at concentrations above Federal MCLs. The seven VOCs include vinyl chloride, trichloroethene, cis-1,2-dichloroethene, 1,2-dichloropropane, tetrachloroethene, benzene, and 1,2-dichloroethane. MCLs for these chemicals are shown in Tables 4-4 and 4-5, along with sample analytical data. Vinyl chloride was most commonly found at concentrations above its MCL of 2  $\mu\text{g/l}$  in comparison to the other six VOCs listed.

**4.8 PRIVATE IRRIGATION WELL RESULTS.** Groundwater samples were collected from 51 PIWs in the Crooked River Plantation Subdivision (Figure 2-4). All PIW samples were analyzed in the on-site laboratory. Twenty-four PIW samples were submitted to the off-site laboratory for confirmatory analysis. On-site laboratory analyses also included analysis of five duplicate samples, and three duplicate samples were submitted to the off-site laboratory. Table 4-7 summarizes analytical data from on-site analysis of PIW samples. Table 4-8 summarizes analytical data from off-site analysis of PIW samples. Table 4-9 provides a cross-reference for PIW locations and sample identifications. Each PIW had a unique location designation assigned to it that is independent of sequential sample numbers. During sampling of the PIWs, measurements of pH, specific conductance, temperature, and flow rates were collected. Appendix G summarizes physical data collected from PIWs. Measurements of pH, specific conductance, and temperature were not taken during the first one-and-a-half days of PIW sampling because the necessary equipment was not mobilized. This situation was corrected on the second day of PIW sampling.

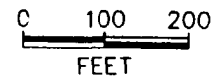
FEET MEAN LOW WATER



**LEGEND**

ISOCONCENTRATION CONTOURS  
(MICROGRAMS PER LITER)

HYDROCONE SAMPLE LOCATIONS  
AND ASSOCIATED TARGET  
VOC CONCENTRATIONS

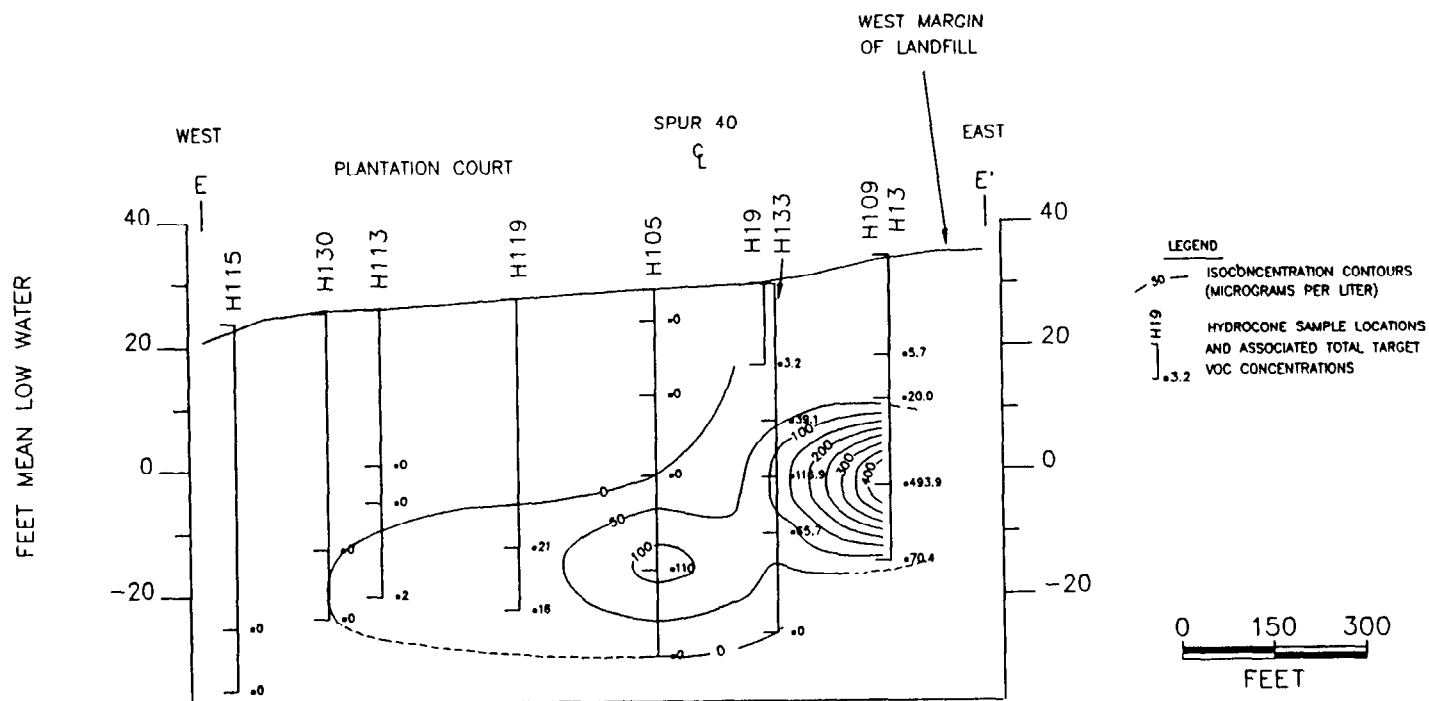


REFER TO FIGURE 2-2 FOR CROSS SECTION LOCATION

KINGSBAY\CHD\MAPS\CHS4-7.dwg			
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CHKD: LBH	APPD: LBH	FIGURE NO.: 4-7	
DATE: 2/18/93	REV.:		

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REFER TO FIGURE 2-2 FOR CROSS SECTION LOCATION

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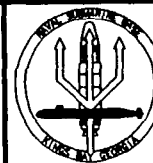
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CHKD:	LBH	APPD:	LBH	FIGURE NO.:	4-8
DATE:	2/16/93	REV.:			

TITLE:

### CROSS SECTION E-E'

#### TOTAL TARGET VOCs

#### ON-SITE ANALYTICAL DATA



INTERIM CORRECTIVE MEASURE  
SCREENING INVESTIGATION  
REPORT

NAVAL SUBMARINE BASE  
KINGS BAY, GEORGIA

Table 4-7 Summary of On-site Laboratory Analysis of Private Irrigation Well Samples

Compound (µg/l)	Sampling Locations (CRP-)													
	MCL	PW-1	PW-2	PW-3	PW-3D	PW-4	PW-5	PW-6	PW-7	PW-8	PW-9	PW-10	PW-11	PW-12
Vinyl chloride	2	NEG	NEG	NEG	NEG	NEG	NEG	POS	POS	NEG	NEG	NEG	NEG	NEG
trans-1,2-dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Trichloroethene	5	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Tetrachloroethene	5	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 UJ	5 UJ
Benzene	5	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 UJ	5 UJ
Toluene	1,000	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 UJ	5 UJ
Ethylbenzene	700	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	10,000	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 U	10 UJ	10 UJ
o-Xylene	10,000	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	5 UJ	5 UJ

Compound (µg/l)	Sampling Locations (CRP-)											
	MCL	PW-13	PW-14	PW-15	PW-16	PW-17	PW-18	PW-18D	PW-19	PW-20	PW-21	PW-22
Vinyl chloride	2	NEG	NEG	NEG	NEG	POS	NEG	NEG	NEG	NEG	NEG	POS
trans-1,2-Dichloroethene	100	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	12 J
Trichloroethene	5	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Tetrachloroethene	5	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	700	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	10,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	10,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

See notes at end of table.

Table 4-7 (continued) Summary of On-site Laboratory Analysis of Private Irrigation Well Samples

Compound ( $\mu\text{g/l}$ )	Sampling Locations (CRP-)												
	MCL	PW-23	PW-24	PW-25	PW-26	PW-27	PW-28	PW-29	PW-29D	PW-30	PW-31	PW-32	PW-33
Vinyl chloride	2	NEG	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	2 U	2 U	2 U	2 U	2 UJ	2 U
trans-1,2-dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U
Trichloroethene	5	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U
Tetrachloroethene	5	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	700	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

Compound ( $\mu\text{g/l}$ )	Sampling Locations (CRP-)												
	MCL	PW-34	PW-35	PW-36	PW-37	PW-38	PW-38D	PW-39	PW-40	PW-41	PW-42	PW-43	PW-44
Vinyl chloride	2	2 U	2 U	2 U	2 U	2 U	2 U	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ
trans-1,2-Dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Trichloroethene	5	5 U	5 U	20	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	700	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

See notes at end of table.

Table 4-7 (continued) Summary of On-site Laboratory Analysis of Private Irrigation Well Samples

Compound	Sampling Locations (CRP-)								
	MCL	PW-45	PW-46	PW-47	PW-47D	PW-48	PW-49	PW-50	PW-51
Vinyl chloride	2	2 U	2 U	5.2	5.2	4.1	2 U	2 U	2 U
trans-1,2-dichloroethene	100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-dichloroethene	70	5 UJ	5 U	5 U	5 U	5.4	5 U	5 U	5 U
Trichloroethene	5	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Ethyl benzene	700	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
m/p-Xylene	<sup>1</sup> 10,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	<sup>1</sup> 10,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

## Notes:

U = compound was not detected at the stated concentration

J = quantitation limit is considered estimated because a continuing calibration standard exceeded QC limits

NEG = compound was not detected

POS = compound was detected but the concentration could not be quantified

 $\mu\text{g/l}$  = micrograms per liter

MCL = Maximum Contaminant Level, USEPA Office of Water, December 1992; The Bureau of National Affairs, Inc., July 1992.

<sup>1</sup> = Total xylenes.

Table 4-8 Summary of Off-site Laboratory Analysis of Private Irrigation Well Samples

Compound (µg/l)	Private Well Locations (CRP-)														
	MCL	PW1	PW2	PW3	PW3D	PW4	PW5	PW6	PW9	PW17	PW21	PW22	PW26	PW29	PW29D
Acetone	NA	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	7 U	19 U	14 U	5 U	5 U
Carbon disulfide	NA	1 U	1 U	1	1 U	1 U	1 U	1	1 U	1 U	20	1 U	5	1 U	1 U
Ethylbenzene	700	1 U	1 U	1 U	1 U	1 U	1 U	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Vinyl chloride	2	1 U	1 U	1 U	1 U	1 U	1 U	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-dichloroethene	70	1 U	1 U	1 U	1 U	1 U	1 U	5	1 U	1 U	1 U	13	1 U	1 U	1 U

Compound (µg/l)	Private Well Locations (CRP-)														
	MCL	PW32	PW33	PW39	PW41	PW42	PW43	PW45	PW46	PW47	PW48	PW50	PW51	PW51D	
Acetone <sup>1</sup>	NA	5 U	6	5 U	5 U	5 U	5	5 U	5	5 U	5 U	5 U	5 U	4 J	
Carbon disulfide	NA	1 U	1 U	1 U	1 U	1 U	28	1 U	1 U	1 U	2	1	2	2	
Ethylbenzene	700	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	
Vinyl chloride	2	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	
cis-1,2-dichloroethene	70	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	8	1 U	1 U	1 U	

Notes: U = compound was not detected at the stated concentration

MCL = Maximum Contaminant Level, USEPA Office of Water, December 1992; The Bureau of National Affairs, Inc., July 1992.

<sup>1</sup> = sample result is considered estimated and flagged with a J qualifier because concentration is less than the Sample Quantitation Limit

Table 4-9 PIW Location Codes and Corresponding Sample Identification

Sample Identification	PIW Location Code <sup>1</sup>
PW1	2706PLDR
PW2	208PLCO
PW3	218PLCO
PW4	215PLCO
PW5	206PLCO
PW6	223PLCO
PW7	204PLCO
PW8	130CACI
PW9	610GALA
PW10	2901PLDR
PW11	203PLCO
PW12	105CACI
PW13	110CACI
PW14	122CACI
PW15	100BECO
PW16	107BECO
PW17	216PLCO
PW18	313SUDR
PW19	113BECO
PW20	105CHPDR
PW21	204GADR
PW22	209COCO
PW23	2903PLDR
PW24	2904PLDR
PW25	201COCO
PW26	205COCO
PW27	2905PLDR
PW28	215PLCI
PW29	703ARPL
PW30	115CACI
PW31	406ELLA
PW32	112CACI
PW33	2705PLDR
PW34	303SUDR

See notes at end of table.

Table 4-9 (continued) PIW Location Codes and Corresponding Sample Identification

Sample Identification	PIW Location Code <sup>1</sup>
PW35	407PICO
PW36	310FAD
PW37	308FADR
PW38	102PIST
PW39	704ARPL
PW40	100WODR
PW41	207COCO
PW42	217PLCO
PW43	214PLCO
PW44	105SULA
PW45	306PIST
PW46	803ARPL
PW47	222PLCO
PW48	210PLCO
PW49	408CKPC
PW50	512SUCO
PW51	400PICO

<sup>1</sup> = Location codes include numeric prefix and alphabetical suffix. Numeric prefix is the house number in the address. The alphabetical suffix is an abbreviation of the street name. An example follows:

<u>Location Code</u>	<u>Address</u>
512SUCO	512 Sunnyside Court

Measurements of pH, specific conductance, and temperature were collected at three intervals during the 15-minute purge of each PIW. Replicate measurements from the PIWs compare well, with little variation over the duration of purging. Values of pH for 41 PIWs tested range from 4.64 standard units (s.u.) to 7.33 s.u., which is slightly acidic to neutral. Specific conductance values range from 64 micromhos per centimeter ( $\mu\text{mhos/cm}$ ) to 490  $\mu\text{mhos/cm}$ , except for one PIW (CRP-PW39) where specific conductance values of 1,197  $\mu\text{mhos/cm}$  and 1,245  $\mu\text{mhos/cm}$  were observed. Temperature values range from 21.5 to 32.6 °C. Flow rates were not measured in cases where purging and sampling was done via a sprinkler head, which accounts for 13 of 51 PIWs. Sprinkler heads were removed prior to purging and sampling so that water flow would be even and aeration minimized. Flow rates measured from spigots range from 3.6 gallons per minute (GPM) to 12 gpm, except for CRP-PW34, where a flow rate of 20 gpm was measured.

Sixteen of the PIW samples contained detectable concentrations of VOCs. Of these 16 samples, 11 PIW samples contained VOCs of origins unrelated to the plume. Field analytical data indicate that five PIW samples contained VOCs potentially related to the plume, including vinyl chloride, cis-1,2-dichloroethene, and ethylbenzene. On-site laboratory analyses detected vinyl chloride in four PIW samples (CRP-PW6, CRP-PW7, CRP-PW17, and CRP-PW22). Off-site analysis did not confirm the presence of vinyl chloride in samples CRP-PW17 and CRP-PW22. Off-site analysis of sample CRP-PW6 detected ethylbenzene and cis-1,2-dichloroethene at a concentration of 5  $\mu\text{g/l}$ , in addition to vinyl chloride. These compounds were not detected during field GC analysis. One PIW sample, CRP-PW7, was collected from a location outside of the limits of the plume, based on data associated with groundwater samples collected using the hydrocone. Vinyl chloride was detected in this sample, but was not quantified because of calibration problems with this compound. Trichloroethene was detected in one PIW sample, CRP-PW36, at a concentration of 20  $\mu\text{g/l}$ . This sample was collected from a location on Fairfield Drive that is approximately 1600 feet southwest of the site. The presence of trichloroethene in this sample is not attributed to the site.

Carbon disulfide was detected in nine PIW samples at concentrations ranging from 1 to 20  $\mu\text{g/l}$ . The marsh deposits common to the Kings Bay area are a natural source of sulfur compounds that can be a food source for bacteria. The presence of carbon disulfide in groundwater is considered to be a by-product of the metabolism of sulfur compounds by indigenous bacteria (Verschuieren, 1983).

## 5.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Subsection 1.3 discusses the regulatory setting under which NSB Kings Bay is operating. The facility currently has a RCRA permit and is required to follow RCRA regulations. Because of the facility's HRS ranking, future remediation at Site 11 may be carried out under CERCLA.

One significant difference between response actions conducted under RCRA and those governed by CERCLA is the establishment of cleanup levels. Under RCRA, site-specific cleanup levels (media protection standards) are established by regulators based on their assessment of actions necessary to protect human health and the environment. Under CERCLA, Section 121(d), remedial actions must comply with ARARs of federal laws and more stringent, promulgated state laws, which are also protective of human health and the environment. As stated in Subsection 1.3, this Interim Corrective Measures Screening report is being prepared consistent with CERCLA FS guidance and addresses criteria outlined in the National Contingency Plan (NCP) and SARA.

This section discusses ARARs for groundwater and air, because these media are the primary exposure pathways. Other media, such as soil and sediment, may need to be addressed for the CMS. Development of ARARs for other media will be similar to the processes discussed herein for groundwater and air.

5.1 DEFINITION OF ARARs. To properly consider ARARs and to clarify their function in this Interim Corrective Measures Screening Investigation, ARARs have been defined following two components presented in the NCP: (1) applicable requirements, and (2) relevant and appropriate requirements.

Applicable requirements are federal and state requirements that specifically address substances or contaminants and actions. An example of an applicable requirement is the use of Maximum Contaminant Levels (MCLs) for a site where groundwater contamination enters a public water supply.

Relevant and appropriate requirements are federal and state requirements that, while not legally applicable, can be applied if site circumstances are sufficiently similar to those covered by jurisdiction, and if use of the requirement is appropriate. For example, MCLs would be relevant and appropriate requirements at a site where groundwater contamination could affect a potential (rather than actual) drinking water source.

Applicable requirements and relevant and appropriate requirements are considered equivalent compliance standards for CERCLA site cleanups.

SARA also identifies a "to be considered" (TBC) category, which includes federal and state non-regulatory requirements such as criteria, advisories, and guidance documents. TBCs do not have the same status as ARARs; however, if no ARAR exists for a chemical or particular situation, TBCs can be used to confirm that a remedy is protective of human health and the environment.

ARARs or risk-based, regulator-determined cleanup levels must be attained for hazardous substances remaining on site at the completion of the remedial action. Remedial action implementation should also comply with ARARs (and TBCs, as appropriate) to protect public health and the environment. Generally, ARARs pertain to either contaminant levels or to performance or design standards to

confirm protection at all points of potential exposure. ARARs are divided into three general categories: chemical-specific, location-specific, and action-specific.

Chemical-specific requirements establish the remedial action objectives because they set health- or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, and contaminants. They govern the extent of site remediation by providing either actual cleanup levels or a basis for calculating such levels. If a chemical has more than one requirement that is an ARAR, the most stringent generally should be attained. If no ARAR exists, or if the ARAR for a substance is established as not sufficiently protective, the federal or state TBC should be used in conjunction with the risk assessment to set the appropriate cleanup level.

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because of a site's particular characteristic or location. Site features governed by location-specific ARARs may include natural features such as wetlands, floodplains, and sensitive ecosystems. These ARARs provide a basis for assessing existing site conditions, which subsequently aid in assessing potential remedies. Location-specific ARARs will be addressed in the CMS.

Action-specific ARARs are usually technology- or activity-based limitations controlling actions conducted at hazardous waste sites. These requirements are triggered by the activities associated with the components selected to develop proposed corrective measures. Action-specific requirements do not in themselves establish the corrective measure; rather, they indicate how a selected corrective measure must be achieved. As remedial alternatives are developed, action-specific ARARs also provide a basis for assessing feasibility and effectiveness. During the CMS detailed analysis of remedial alternatives, each alternative will be evaluated for compliance with the applicable, or relevant and appropriate, standards of each ARAR. This analysis will not be presented in this interim CMS.

Only chemical-specific ARARs will be discussed in this report because no actions have been identified. Therefore, location- and action-specific ARARs cannot be addressed at this time.

**5.2 CHEMICAL-SPECIFIC ARARs.** Chemical-specific ARARs for NSB Kings Bay, identified in Table 5-1, are described below. The State of Georgia does not classify groundwater aquifers. Therefore, assuming all groundwater may be a potential drinking water supply, the Safe Drinking Water Act (SDWA), MCLs, and Maximum Contaminant Level Goals (MCLGs), which are applicable to public water systems, are relevant and appropriate cleanup levels. MCLs are legally enforceable federal drinking water standards, based on advisories and health effects of a contaminant, and reflect the technical and economic feasibility of removing the contaminants from water supplies. SDWA MCLGs are non-enforceable health goals established by the USEPA and set at levels that would result in no known or anticipated adverse health effects with an adequate margin of safety. CERCLA Section 121 (d) states that remedial actions shall attain MCLGs where they are relevant and appropriate based on the circumstances of release. Ambient

Table 5-1 Chemical Specific ARARs

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS
<u>FEDERAL</u>		
RCRA Subpart F - Groundwater Protection Standards(40 CFR 264.94)	Applicable	Subpart F outlines three possible standards for setting cleanup levels for remediation of groundwater contamination attributable to a RCRA facility. These standards include: (1) Maximum Contaminant Levels (MCLs), (2) background concentrations, and (3) Alternative Concentration Limits
Safe Drinking Water Act (SDWA) - MCLs (40 CFR 141.11 - 141.16)	Relevant and Appropriate	MCLs have been promulgated for a number of common organic and inorganic contaminants. These are legally enforceable levels that regulate the concentration of contaminants in public drinking water supplies, and are considered for groundwater aquifers used for drinking water or potential sources of drinking water. Groundwater contaminant concentrations are compared to MCLs during the evaluation of risks to human health due consumption of groundwater.
SDWA - Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50 - 141.51)	Relevant and Appropriate	MCLGs are health-based criteria for a number of organic and inorganic contaminants in drinking water sources. MCLGs are used in cases in which multiple contaminants or pathways of exposure present extraordinary risks to human health. As promulgated under SARA, MCLGs should be considered relevant and appropriate for groundwater remediation of actual and potential drinking water supplies.
Federal Ambient Water Quality Criteria (AWQC)	Applicable	Federal AWQC include (1) health-based criteria for 95 carcinogenic and noncarcinogenic compounds and (2) water quality parameters. AWQC, established for the protection of human health, are set at levels considered safe for consumption of drinking water as well as consuming fish. Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release. These factors will determine whether AWQC are relevant and appropriate.
Clean Air Act, Title I, Air Quality and Emission Limitations Title III, Hazardous Air Pollutants	Relevant and Appropriate	Title I establishes air quality standards and emission limitations, including requirements for ozone protection and national emissions standards for hazardous air pollutants. Title III lists numerous chemicals identified as hazardous air pollutants and provides for USEPA promulgation of regulations establishing emission standards for categories and subcategories of sources. The list of chemicals includes: benzene, chlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, 1,1-dichloroethane, 2-butanone, toluene, and vinyl chloride.
USEPA Regulations on National Ambient Air Quality Standards (NAAQS) (40 CFR 50)	Relevant and Appropriate	These regulations set forth national primary and secondary air quality standards for protection of public health and welfare. A level of 0.12 ppm has been established as a primary and secondary air quality standard for ozone. VOCs are precursors of ozone formation. No source of VOC emissions may cause or contribute to a violation of the ozone NAAQS.
USEPA Regulation National Emission Standard for Hazardous Air Pollutants (NESHAP) (40 CFR 61)	Relevant and Appropriate	These regulations establish emission standards for various types of sources of emissions of air pollutants designated as hazardous or having serious health effects from ambient exposure to the substance. Benzene and vinyl chloride have been designated hazardous air pollutants. Substances causing serious health effects include chlorinated benzenes, tetrachloroethene, and toluene.

Table 5-1 (continued) Chemical Specific ARARs

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS
<u>FEDERAL (TO BE CONSIDERED)</u>		
USEPA Reference Doses (RfDs)	Relevant and Appropriate	RfDs are dose levels developed by the USEPA for noncarcinogenic effects for lifetime exposure.
USEPA Cancer Assessment Group Slope Factors (CSFs)	Relevant and Appropriate	CSFs are developed by the USEPA from Health Effects Assessment (HEA) or evaluation by the Carcinogenic Assessment Group.
Acceptable Intake - Chronic (AIC) and Subchronic (AIS) - USEPA Health Assessment Documents	Relevant and Appropriate	AIC and AIS values are developed from RfDs and HEAs for noncarcinogenic compounds.
American Conference of Governmental Industrial Hygienists (ACGIH), Threshold Limit Values (TLVs), Time Weighted Averages (TWAs), and Short Term Exposure Limits (STELs)	Relevant and Appropriate	TLV-TWAs and TLV-STELs are issued as consensus standards for controlling air quality in workplace environments.
<u>STATE OF GEORGIA</u>		
Georgia Rules for Safe Drinking Water (Georgia Department of Natural Resources (DNR), July 1992)	Applicable	Georgia MCLs for drinking water have been promulgated for a number of common organic and inorganic contaminants. These are legally enforceable levels that regulate the concentration of contaminants in public drinking water supplies, and are considered for groundwater aquifers used for drinking water or potential sources of drinking water. Groundwater contaminant concentrations are compared to MCLs during the evaluation of risks to human health due to consumption of groundwater.
Georgia Water Quality Control Regulations and Standards	Applicable	Standards established for instream concentrations of the chemical constituents listed by the USEPA as toxic priority pollutants (Section 307(a)(1)) of the federal CWA.
<u>GEORGIA (TO BE CONSIDERED)</u>		
Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions (Georgia DNR, July 1984)	Relevant and Appropriate	These guidelines are used in the review of all air quality applications for construction and operating permits for sources of toxic air pollutants. Acceptable ambient pollutant concentrations are discussed.

Water Quality Criteria (AWQC) are also potentially relevant and appropriate standards under CERCLA Section 121.

RCRA concentration limits (40 CFR 264.94) are applicable to active RCRA facilities and establish three categories of groundwater protection standards: background concentrations, MCLs, and Alternative Concentration Limits (ACLs). RCRA MCLs are equal to SDWA MCLs; therefore, by complying with SDWA MCLs, cleanup will be consistent with RCRA MCLs. If no MCL exists, a background level or health-based (assuming human exposure) ACL may be developed on a case-by-case basis as a groundwater protection standard. ACLs are developed in accordance with 40 CFR 264.94 and are based on the concentration at which the contaminant will adversely affect groundwater quality and hydraulically connected surface water. The ACL takes into consideration factors such as physical and chemical characteristics of the waste, hydrogeological characteristics of the site, the quantity and direction of groundwater flow, current and future uses of groundwater, existing quality of the area groundwater, and the persistence and permanence of adverse effects. Additional factors are listed in 40 CFR 264.94.

The Georgia Hazardous Waste Management Rules are applicable when developing appropriate cleanup standards at a site. Georgia Hazardous Waste Management Rules are consistent with the regulatory requirements of 40 CFR Parts 260 through 270; therefore, RCRA groundwater protection standards are also applicable to Site 11 under Georgia regulations. In addition, Georgia Drinking Water Standards or MCLs (Georgia Department of Natural Resources, July 1992) are applicable when developing appropriate cleanup levels. Georgia groundwater quality standards, MCLs, MCLGs, AWQC, background levels, and ACLs will all be assessed and used during the evaluation of an interim corrective measure at Site 11 to develop appropriate cleanup levels. A preliminary list of chemicals of potential concern and the associated chemical specific ARARs are presented in Table 5-2.

Federal non-regulatory criteria to be considered when ARARs are not available for specific contaminants or that may be used in conjunction with the risk assessment include USEPA Risk Reference Doses and USEPA Carcinogenic Assessment Group Cancer Slope Factors (USEPA, 1989a).

Table 5-2 Chemical Specific Values

Chemical µg/l	Federal MCL µg/l	MCLG µg/l	Federal AWQC µg/l	Georgia Drinking <sup>1</sup> Water Standards µg/l	Georgia Surface <sup>2</sup> Water Criteria µg/l
Acetone	-----	-----			
Ethylbenzene	700	700	1,400	700	28,718
Chlorobenzene	100	100	488	100	20
1,1-Dichloroethane	-----	-----	-----	-----	-----
trans-1,2-Dichloroethene	100	100	-----	100	136,319
Methylene Chloride	5	0	-----	-----	1,578
2-Butanone	-----	-----			
Tetrachloroethene	5	0	0.8	5	8.85
Carbon Disulfide	-----	-----			
Trichloroethene	5	0	2.7	5	81
Vinyl Chloride	2	0	2.0	2	525
Toluene	1,000	1,000	14,300	1,000	301,941
Bromomethane	-----	-----	-----	-----	470.8
1,1-Dichloroethene	7	7	0.033	7	3.2
cis-1,2-Dichloroethene	70	70	-----	70	-----
Benzene	5	0	0.66	5	71.28
1,2-Dichlorobenzene	600	600	-----	600	2,600
1,4-Dichlorobenzene	75	75	-----	75	2,600
Dichlorodifluoromethane	-----	-----	-----	-----	-----
m/p-xylene	*	*	-----	-----	-----
o-xylene	*	*	-----	-----	-----
xylene (Total)	10,000	10,000	-----	10,000	-----
1,2-Dichloroethane	5	0			
1,2-Dichloropropane	5	0			
2-Hexanone	-----	-----			
4-Methyl-2-pentanone	-----	-----			

## Notes:

\* = See xylenes (total)  
MCL = Maximum Contaminant Level, USEPA Office of Water, December 1992; The Bureau of National Affairs, Inc., July 1992  
MCLG = Maximum Contaminant Level Goal, USEPA Office of Water, April 1992; The Bureau of National Affairs, July 1992  
Federal AWQC = Federal Ambient Water Quality Criteria  
Federal AWQC = Water Quality Criteria Summary Concentrations, Published Criteria (Water and Organisms) USEPA Office of Science and Technology Health and Ecological Criteria Division, May 1991  
µg/l = micrograms per liter

<sup>1</sup> Georgia Drinking Water Standards, Rules for Safe Drinking Water, Chapter 391-3-5, Revised July 1992, Rules of Georgia Department of Natural Resources Environmental Protection Division  
<sup>2</sup> Georgia Surface Water Criteria, Georgia Water Quality Control Specifications and Standards, The Bureau of National Affairs, Inc., August 1991

## 6.0 SCREENING RISK EVALUATION

6.1 INTRODUCTION. This Screening Risk Evaluation (SRE) has been prepared to evaluate whether exposure to the contaminants released into the groundwater from Site 11, the Old Camden County Landfill, pose a potential risk to humans living in the Crooked River Plantation Subdivision. This document is not a baseline risk assessment but will help determine if an interim corrective measure or corrective measure study is required at this site.

The SRE was conducted according to standard USEPA guidelines found in the following documents: Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A) (USEPA, 1989a); RCRA Facility Investigation (RFI) Guidance (1989b); Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Proposed Rule (1990b); Exposure Factor Handbook (USEPA, 1990c); Supplemental Region IV Risk Assessment Guidance (USEPA, 1991e); and Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (USEPA, 1991d). The SRE was conducted using the traditional four phases of a human health risk assessment: data collection and evaluation, exposure assessment, toxicity assessment, and risk characterization (USEPA, 1989a).

In the first phase, data collection and evaluation, the data used in the SRE will be briefly reviewed and information relevant to the SRE will be discussed. This discussion includes identifying the contaminants detected at the site, the media in which the contaminants were detected, the frequency of detection, the concentration range of each contaminant, and the selection of the contaminants to be studied in the SRE, also called the potential contaminants of concern (PCOCs).

In the next step, the exposure assessment, the potential for chemical exposure to humans is examined. This process includes identifying human receptors that could possibly be exposed to the PCOCs at the site, the relevant exposure pathways by which the humans might be exposed to the PCOCs, and the exposure models and equations used to estimate the dose of each PCOC that these humans might receive.

A brief discussion of the known toxicity of each PCOC is covered in the third section of the SRE, the toxicity assessment. In this step, the carcinogenic potential for each PCOC is evaluated using USEPA toxicity factors. Known non-carcinogenic toxicity resulting from exposure to each PCOC is also presented along with the relevant USEPA toxicity factors.

In the fourth step, risk characterization, the potential carcinogenic and non-carcinogenic risks are calculated for each exposure pathway. The methodology and equations used in these calculations are also briefly reviewed.

After the carcinogenic and non-carcinogenic risks are discussed in the SRE, the underlying assumptions used in calculating these values will also be reevaluated. Assumptions that may tend to under- or over-estimate the actual carcinogenic and non-carcinogenic risks at the site will be identified and discussed.

In this SRE two approaches will be examined. In the first approach, an exposure scenario representing the "worst possible case" will be examined. This scenario is not meant to represent any reasonable exposure situation (and many of the

exposure assumptions can be considered unreasonable) but rather to provide a conservative upper estimate of potential risk.

The USEPA has established that "...for known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between  $1 \times 10^{-4}$  and  $1 \times 10^{-6}$  using information on the relationship between dose and response " (NCP, 1990). For non-carcinogenic toxic effects the USEPA "assumes that there is a level of exposure below which it is unlikely for even sensitive populations to experience adverse health effects" (USEPA, 1989a). If the exposure level exceeds this threshold (i.e., 1.0) there may be concern for potential non-carcinogenic effects (USEPA, 1989a).

Using these carcinogenic and non-carcinogenic risk ranges as the basis for comparing risks, the approach used in the SRE can be viewed as a screening tool. If the carcinogenic (and non-carcinogenic) risks under this exposure scenario are considered acceptable using standard USEPA exposure guidance, then the actual risks associated with a more likely exposure scenario are also acceptable.

However, if the risks predicted by the maximum possible exposure scenario are considered unacceptable using standard USEPA guidance, then a more realistic exposure scenario also needs to be examined to determine if the risks are the result of the excessively conservative exposure estimates used in the maximum possible exposure scenario or if there is the potential for an unacceptable health risk at the site. That is the purpose of the second, maximum likely exposure approach. It examines the carcinogenic, and non-carcinogenic risks, of a reasonable exposure scenario and may help answer the question of whether or not there is possibly an unacceptable human health risk at the site.

This SRE does not make risk management decisions. The use of two exposure scenarios, however, provides risk managers' with additional risk information to make informed risk management decisions concerning the potential for actual health risks at the site.

**6.2 DATA COLLECTION AND EVALUATION.** The QC information and associated analytical data that the SRE relies upon are provided in detail in Section 3.0 and subsections 4.2.2 through 4.7. The data generated by the on-site laboratory were useful for screening groundwater samples and for delineating the extent of the groundwater plume in the subdivision. However, the on-site laboratory does not have sufficient QC for the purposes of a human health risk evaluation.

Screening level air monitoring was conducted in the subdivision, and soil gas was analyzed at the landfill to determine if any of the contaminants in the groundwater were passing through the soil into the air. Although some VOCs were detected in the soil gas in the landfill, none were detected in any air samples beyond the boundary of the landfill and none of the samples were sent to off-site laboratories for NEESA Level D analysis. As a result, these data do not have sufficient QC for the SRE.

Three surface water samples and three sediment samples were collected from Porcupine Lake and analyzed in the off-site laboratory for VOCs and SVOCs at NEESA Level D. However, as discussed in subsection 4.2.2, no site related contaminants were detected in either the sediment or surface water samples.

The only analytical data presently available with sufficient QC to support a human health risk assessment, and which indicates the presence of potential contaminants of concern, are the data for the VOCs in the groundwater plume.

These data come from the hydrocone and PIW samples that were sent to the off-site laboratory for Level D analyses. Therefore, only these data will be used in the SRE. Table 6-1 provides the analytical results for the VOC analyses of the groundwater used in this SRE.

The results of this SRE are limited and focused on the risks associated with exposure to VOCs in the groundwater. A future baseline risk assessment will be conducted which includes complete Target Analyte List (TAL) and TCL analyses of groundwater, soil, and air and the risks associated with exposure to the media.

**6.2.1 Selection of Potential Contaminants of Concern.** All but two of the contaminants detected in the groundwater were selected as PCOCs. Acetone and carbon disulfide were not selected because they were both detected in several rinseate blanks at comparable levels to those found in the environmental samples and they may be sampling artifacts. This is discussed in detail in subsection 3.2.2.1. In addition, carbon disulfide was not selected as a potential contaminant of concern because it is believed to be a naturally occurring background chemical. The landfill and the subdivision were built next to a swampy wetland, and it is common to find carbon disulfide in such areas due to natural anaerobic bacterial processes (Verschueren, 1983). The analytical results of background monitoring wells at similar sites in the area, Naval Air Station Cecil Field and Naval Station Mayport located in Jacksonville, FL, and Marine Corp Logistics Base Albany located in Albany, GA, have also indicated the presence of carbon disulfide at comparable levels to those in the groundwater found at the site.

**6.2.2 Exposure Point Concentration** The concentration of each PCOC in the groundwater used in the risk evaluation is called the Exposure Point Concentration (EPC). USEPA Region IV has specific guidance for estimating the EPC. This guidance indicates that, for groundwater, "data points for calculating the groundwater EPC for a future scenario should consist of wells located within the contamination plume" (USEPA, 1991d). For the purposes of this SRE, the phrase "within the contamination plume" will be construed to mean those hydrocone or private well locations where the PCOCs were detected.

The 95 percent upper confidence limit (UCL) of the mean concentration was calculated for each PCOC in accordance with procedures specified in the regional risk assessment guidance (USEPA, 1991a). Data were log (natural) transformed, the arithmetic means and standard deviations of the transformed data were calculated, and the 95 percent UCLs computed using the equation:

$$UCL = e^{(\bar{x} + 0.5s^2 + sH/\sqrt{n-1})}$$

Table 6-1 The VOCs Detected in the Groundwater Plume Emanating from the Old Camden County Landfill

Contaminant	<sup>1</sup> Number of Detections/Number of Samples	<sup>2</sup> Range of Detections ( $\mu\text{g/l}$ )	<sup>3</sup> Potential Contaminant of Concern
Acetone	11/41	5 - 330	No
Benzene	5/41	2 - 5	Yes
2-Butanone (methyl ethyl ketone)	6/41	2 - 580	Yes
Chlorobenzene	1/41	10	Yes
Carbon Disulfide	11/41	1 - 28	No
1,4-Dichlorobenzene	1/41	12	Yes
1,1-Dichloroethane	5/41	2 - 24	Yes
1,2-Dichloroethane	1/41	9	Yes
cis-1,2-Dichloroethene	11/41	1 - 3,600	Yes
trans-1,2-Dichloroethene	2/41	1 - 23	Yes
1,2-Dichloropropane	2/41	1 - 6	Yes
Ethyl benzene	8/41	2 - 41	Yes
2-Hexanone (methyl butyl ketone)	4/41	11 - 70	Yes
4-Methyl-2-pentanone (methyl isobutyl ketone)	6/41	12 - 110	Yes
Tetrachloroethene	1/41	3	Yes
Toluene	6/41	4 - 580	Yes
Trichloroethene	3/41	4 - 45	Yes
Xylenes (total)	5/41	1 - 120	Yes
Vinyl chloride	4/41	2 - 310	Yes

Notes: VOC = Volatile Organic Compound  
 $\mu\text{g/l}$  = micrograms per liter

<sup>1</sup>Five duplicate samples were collected and the results averaged. Duplicates count as one sample for determining number of samples collected.

<sup>2</sup>The highest concentration detected, even duplicates, used for concentration range.

<sup>3</sup>See text for discussion of "Potential Contaminant of Concern."

where

UCL = the 95 percent upper confidence limit of the mean,  
 $e$  = 2.71828,  
 $\bar{x}$  = the arithmetic mean of the transformed data,  
 $s$  = the standard deviation of the transformed data,  
 $H$  = statistical variable obtained from Table A12 of Gilbert (1987), and  
 $n$  = number of samples.

For each chemical, the 95 percent UCL was then compared with the maximum detected concentration. If the 95 percent UCL exceeded the maximum detected concentration, the maximum detected concentration was used, instead of the 95 percent UCL, as the EPC. Also, 95 percent UCLs for each PCOC could not be calculated if they were detected in less than four different samples because the statistical variable used in the equation above requires at a minimum of four data points. For these PCOCs, the maximum detected concentration was used as the EPC. As Table 6-2 shows, the maximum detected concentrations for each PCOC was lower than the 95 percent UCL. Thus, for both of the exposure scenarios, the maximum detected concentration for each PCOC was used as the EPC.

**6.3 EXPOSURE ASSESSMENT.** In this section the possible routes of exposure to the PCOCs in the groundwater are described. More than 90 of the homes in the Crooked River Plantation Subdivision have PIWs. The residents who completed the well survey forms indicated that the groundwater from the PIWs is used for a variety of non-potable purposes, including irrigation, washing of cars and yard items, and as drinking water for pets (Appendix B). It is also possible that the groundwater could be used to fill backyard swimming pools, children's wading pools, and for other water-using play devices.

Based upon the information presently available, the only route of exposure to the PCOCs in the groundwater is via the PIWs in the subdivision. No information presently available suggests that this water is being used for potable purposes and all of the homes in the Crooked River Plantation Subdivision are connected to the City of St. Marys municipal water supply.

**6.3.1 Potential Human Receptors and Exposure Pathways.** The potential human receptors in the Crooked River Plantation Subdivision are the people living in the subdivision, regardless of whether they have a PIW or not. Other potential human receptors include past residents, trespassers, visitors, and people who may provide services to residents in the subdivision.

The data provided in subsection 4.7 indicates that no PCOCs are present in the groundwater above 10 feet bgs and that the majority of the contamination is found in the groundwater below 25 feet bgs. The data from subsection 4.3 indicate that no PCOCs were detected in either the surface water or sediments in Porcupine Lake. Thus, exposure to the water and sediments in this lake is not an exposure pathway to the PCOCs detected in the groundwater. The air screening data presented in subsection 4.4 indicate that none of the PCOCs detected in the groundwater are volatilizing into the air and inhalation of soil gas or vapors released from the groundwater through the soil is also not an exposure pathway.

Therefore, the only presently identified route for human exposure to the PCOCs in the groundwater is through the use of the PIWs in the Crooked River Plantation

Table 6-2 The Chemicals Detected, Range of Detections, and Exposure Point Concentrations for the Potential Chemicals of Concern in the Groundwater Plume at the Crooked River Plantation Subdivision

Chemical	<sup>1</sup> Number of Detections/Number of Samples	<sup>2</sup> Range of Detections (µg/l)	<sup>3</sup> 95% UCL (µg/l)	EPC (µg/l)
Benzene	5/41	2 - 5	8	5
2-Butanone (methyl ethyl ketone)	6/41	2 - 580	1,741,483	580
Chlorobenzene	1/41	10	NC	10
1,4-Dichlorobenzene	1/41	12	NC	12
1,1-Dichloroethane	5/41	2 - 24	8,521	24
1,2-Dichloroethane	1/41	9	NC	9
cis-1,2-Dichloroethene	11/41	1 - 3,600	6,257	3,600
trans-1,2-Dichloroethene	2/41	1 - 23	NC	23
1,2-Dichloropropane	2/41	1 - 6	NC	6
Ethyl benzene	8/41	2 - 41	42	41
2-Hexanone (methyl butyl ketone)	4/41	11 - 70	1,179	70
4-Methyl-2-pentanone (methyl isobutyl ketone)	6/41	12 - 110	205	110
Tetrachloroethene	1/41	3	NC	3
Toluene	6/41	4 - 580	43,708	580
Trichloroethene	3/41	4 - 45	NC	45
Xylenes (total)	5/41	1 - 120	1.2x10 <sup>11</sup>	120
Vinyl chloride	4/41	2 - 310	4.7x10 <sup>12</sup>	310

Notes: µg/l = micrograms per liter

95% UCL = 95 percent Upper Confidence Limit

EPC = Exposure Point Concentration

NC = cannot be calculated with less than 4 data points

<sup>1</sup>Duplicates count as one sample for determining number of samples collected.

<sup>2</sup>The highest concentration detected, even duplicates, used for concentration range.

<sup>3</sup>The average concentration of duplicate samples was used for calculation of 95% UCL.

Subdivision. The exposure pathways examined in this SRE are all associated with known or potential uses of the groundwater. Human receptors could be exposed to the PCOCs in the groundwater through the following exposure pathways:

- inhalation of the VOCs released during irrigation;
- dermal contact with the water during irrigation, washing activities, and swimming; and
- incidental ingestion of the groundwater during irrigation, washing activities, and swimming.

As discussed in subsection 6.1.1, two exposure scenarios will be examined in this SRE, a maximum possible exposure and a more realistic case, the maximum likely exposure. Following standard USEPA risk assessment guidance, the SRE will analyze the risks associated with exposure to the PCOCs in the groundwater for adults and children separately (USEPA, 1991d). In both the maximum possible exposure scenario and the maximum likely exposure scenario, the SRE will assume that the adults and children live in a home with a PIW screened at an interval that captures groundwater from the depths where the highest contamination was detected, 25 to 40 feet bgs. Further, both exposure scenarios will assume that the groundwater is used for purposes such as irrigation, washing of outdoor objects, filling swimming pools, and for other water play devices.

**6.3.2 The Maximum Possible Exposure Scenario** In this exposure scenario the irrigation systems are used for 2 hours per day for 350 days of the year. Concurrent precipitation or other weather factors are not considered. Adults and children are exposed to the PCOCs volatilized from the groundwater via the irrigation systems for 24 hours per day, 350 days per year. The atmospheric concentration of each PCOC used in this exposure scenario is described in subsection 6.3.5.

In this exposure scenario, adults and children are directly exposed to the spray from the irrigation system for 2 hours per day, 350 days per year. The groundwater is assumed to contain the EPC concentration of each PCOC. Because this scenario also assumes that 100 percent of the PCOCs volatilize during the irrigation process, this is an unrealistic overestimation of exposure conditions.

In the swimming scenario, both the adults and children are exposed by dermal exposure to water containing the EPC concentration of each PCOC. Following specific Region IV guidance, swimming pool exposures are assumed to occur 88 days per year with each swimming event lasting 4 hours. This assumption is used for both adults and children. The scenario also assumes that no PCOCs volatilize from the pool water into the air.

**6.3.3 The Maximum Likely Exposure Scenario** In this scenario all the irrigation systems are used for 2 hours per day, 350 days per year. The adults and children are exposed by inhalation to the PCOCs released from the irrigation systems 24 hours per day, 350 days per year. Except for vinyl chloride, the volatilization factor used for predicting volatilization from the groundwater in this scenario is 90 percent rather than 100 percent used in the preceding exposure scenario. The atmospheric concentration of each PCOC used in this exposure scenario is described in subsection 6.3.5.

The children and adults are also directly exposed to the spray from the irrigation system but the exposure duration is 10 minutes per exposure with an exposure frequency of 30 days per year. The water from the spray contains only 10 percent of the EPC concentration of the PCOCs in the groundwater.

There is a difference between the adult and child swimming scenarios. The adult swimming pool is assumed to be an outdoor pool approximately 3 to 4 feet deep. The pool is assumed to remain full and is not emptied after each use. The water lost to splashing and evaporation is replaced by new groundwater but this volume is assumed to be less than 1 percent of the total pool volume. Except for vinyl chloride, the EPC concentration of the PCOCs in the adult pool water is assumed to be 10 percent with the other 90 percent lost to volatilization. The vinyl chloride EPC concentration is assumed to be zero percent. Inhalation of the PCOCs lost due to volatilization is not considered in this exposure.

The child's swimming pool is assumed to be a shallow wading-type pool that is less than 2 feet deep. The water in a child's pool is emptied after each use and water lost due to splashing during the swimming event is constantly replenished using groundwater. This exposure scenario is also used to approximate dermal exposure during the use of water play devices. The water in the child's swimming scenario is assumed to contain 100% of the EPC concentration of the PCOCs except for vinyl chloride which is 50%. This assumption is used to represent a water hose constantly flowing into a child's wading pool or a water play device in which the water supply is constantly being replaced.

Following specific Region IV guidance, swimming pool exposures are assumed to occur 88 days per year with each swimming event lasting 4 hours. This assumption is used for both the adult and child's swimming pool exposures.

It should be noted that the volatilization assumptions used in both the maximum possible exposure and the maximum likely exposure scenarios are "screening level" assumptions. The full baseline risk assessment that will follow this document will make use of more refined volatilization models to predict volatilization rates in the exposure scenarios.

**6.3.4 Other Risk Assessment Assumptions** A number of exposure assumptions were common to both the maximum possible exposure and the maximum likely exposure scenarios. These assumptions include the concentrations of the PCOCs in the groundwater, the period that the children and adults live in the homes, and physiological, physical, and behavioral characteristics of the adults and children.

USEPA risk assessment guidance states that a child's exposure period is 6 years and an adult exposure period is 30 years comprised of a 6 year exposure using children's exposure assumptions and a 24 year exposure using an adult's exposure assumption (USEPA, 1989a; 1990c; 1991d). However, many of the residents in the subdivision are members or dependents of the U.S. military. The transient nature of persons in this profession suggests that the 6- and 30-year exposure periods may be overestimates for these people. Therefore, an exposure period of 3 years, to simulate a normal military tour of duty, was also examined in the SRE for both the children and the adults.

Adults are assumed to weigh 70 kilograms (kg) and have an average lifespan of 70 years (USEPA, 1991d). For risk assessment purposes, children are defined as those less than or equal to 6 years of age with an average body weight of 15 kg

(USEPA, 1989a, 1990c, 1991d). Children and adults are assumed to breath 20 cubic meters (m<sup>3</sup>) of air per day.

Body surface areas are used to estimate dermal (skin) absorption of the PCOCs during swimming activity and exposure to the spray. For the swimming pool scenario, an adult is assumed to have a full body surface area of 19,900 square centimeters (cm<sup>2</sup>) whereas a child's body surface area is assumed to be 7,280 cm<sup>2</sup> (USEPA, 1990c). For the purposes of estimating the dermal absorption of the PCOCs due to exposure to the spray, adults and children are assumed to be wearing shorts, short-sleeved shirts, and shoes with exposed skin areas of 5,300 cm<sup>2</sup> and 1,990 cm<sup>2</sup>, respectively (1990c).

Incidental ingestion of the groundwater is also assumed to occur in both the swimming and spray exposure scenarios. USEPA guidance suggests that 50 milliliters (ml) per hour be used for incidental ingestion during the swimming scenario (USEPA 1989a; 1990c). This value will also be used for estimating incidental ingestion of groundwater during exposure to the spray during irrigation.

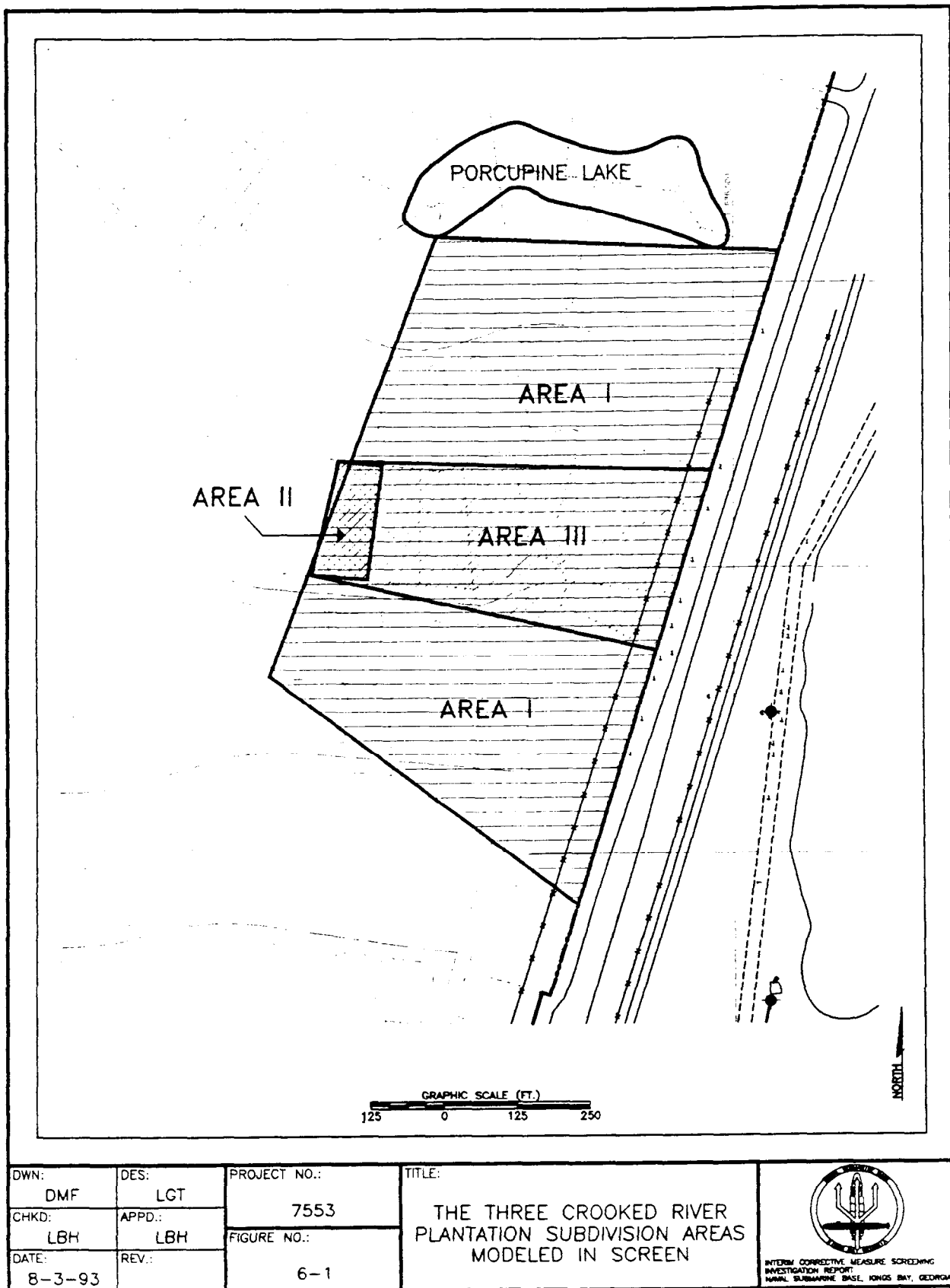
**6.3.5 Air Modeling Used for the SRE** The USEPA SCREEN model was used in the SRE to estimate the PCOC concentrations in the air resulting from operation of the sprinkler systems in the Crooked River Plantation Subdivision. SCREEN is a Gaussian dispersion model that the USEPA recommends for conducting air dispersion modeling. The highest air concentrations predicted by SCREEN were used in the subsequent risk calculations for inhalation exposure to the PCOCs released during the use of the irrigation systems. Three different sized areas of the subdivision were modeled to determine which combination of area size and number of sprinklers would result in the highest air concentrations of the PCOCs released during irrigation. The modeled area resulting in the highest air concentration was selected for use in the risk analysis.

AREA I was a rectangle covering most of the area of the contaminant plume and extending approximately 1,000 feet north to south and 600 feet west to east (Figure 6-1). AREA II was one of the smallest properties with a sprinkler system. AREA III had the highest number of PIWs in the smallest geographical area.

The highest air concentrations of PCOCs released were predicted for AREA I. Therefore, the assumptions associated with this study area (i.e., size and number of sprinkler systems the area) were used for analysis of all of the PCOCs in the groundwater plume in the Crooked River Plantation Subdivision.

The AREA I, 1-hour maximum air emission rates for the PCOCs in the groundwater were used to calculate the 24-hour average air concentrations for the inhalation exposure scenario. This calculation assumes that the irrigation systems were used 2 hours per day and that this 2-hour event was the only route by which the PCOCs were released into the air. The 24-hour average air concentration of each PCOC was calculated as the 24-hour, time-weighted-average using the 1-hour maximum emission rates in the formula:

$$24\text{-Hour Average } (\mu\text{g/hr}) = \frac{1\text{-Hour Maximum } (\mu\text{g/hr}) \times 2 \text{ hours/Day}}{24 \text{ Hours/Day}}$$



The air emission rates for all of the PCOCs in the groundwater plume at the Crooked River Plantation Subdivision are provided in Table 6-3. Also provided are the 1- and 24-hour maximum air concentrations for each contaminant predicted by SCREEN. The full computer printout of the air concentrations of the PCOCs predicted by the SCREEN model are provided in Appendix H.

The end result of this exposure assessment is an estimate of the daily intake of each PCOC by each exposure route. When assessing the potential for carcinogenic risks, the intake of each PCOC for each exposure route is averaged over a person's lifetime. This dose is called the Lifetime Adjusted Daily Dose (LADD). When assessing the potential for non-carcinogenic risks, the intake of each PCOC for each exposure route is expressed as a daily dose. This dose is called the Adjusted Daily Dose (ADD).

The LADDs and ADDs are calculated using the equations presented in Table 6-4 and the assumptions described in the exposure assessment. These assumptions, for both the maximum possible exposure scenario and the maximum likely exposure case scenario, are summarized in Table 6-5. The resulting LADDs and ADDs for all of the PCOCs estimated using these equations and exposure assumptions are provided in Appendix I.

**6.4 TOXICITY ASSESSMENT.** The toxicity assessment provides information regarding the potential for a specific PCOC to cause adverse health effects in humans. It also characterizes the relationship between the dose of that chemical and the incidence of adverse health effects. The purpose of this assessment is to identify, for each chemical, health effects associated with the chemical and a dose-response value that can be used to quantitatively evaluate the potential health risks as a function of exposure.

Separate risk evaluations are conducted for carcinogenic and non-carcinogenic effects. The USEPA has derived cancer slope factors (CSFs) and Reference Doses (RfDs) to evaluate carcinogenic and non-carcinogenic risks, respectively. The USEPA definitions of CSFs and RfDs are as follows.

- The CSF is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The CSF is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime exposure to a particular concentration of a potential carcinogen (USEPA, 1989a).
- The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure concentration for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects. Chronic RfDs are specifically developed to be protective from long-term exposure, longer than 7 years, to a compound (USEPA, 1989a). Subchronic RfDs are the same as chronic RfDs except that they are specifically developed to be protective from exposures during a portion of a life, usually from 2 weeks to 7 years (USEPA, 1989a).

Table 6-3 PCOC Air Emission Rates and Maximum Air Concentrations Predicted by SCREEN in AREA I by the Use of the Groundwater in the Crooked River Plantation Subdivision for Irrigation

Chemical	PCOC Air Emission Rate (g/s)	Maximum 1-Hour Air Concentration ( $\mu\text{g}/\text{m}^3$ )	Maximum 24-Hour Air Concentration ( $\mu\text{g}/\text{m}^3$ )
Benzene	$3.6 \times 10^{-4}$	1.60	$1.33 \times 10^{-1}$
2-Butanone (methyl ethyl ketone)	$8.352 \times 10^{-3}$	37.09	3.09
Chlorobenzene	$1.440 \times 10^{-4}$	$6.40 \times 10^{-1}$	$5.33 \times 10^{-2}$
1,4-Dichlorobenzene	$1.728 \times 10^{-4}$	$7.67 \times 10^{-2}$	$6.40 \times 10^{-2}$
1,1-Dichloroethane	$3.456 \times 10^{-4}$	1.54	$1.28 \times 10^{-1}$
1,2-Dichloroethane	$1.296 \times 10^{-4}$	$5.76 \times 10^{-1}$	$4.80 \times 10^{-2}$
cis-1,2-Dichloroethene	$5.184 \times 10^{-2}$	230.20	19.18
trans-1,2-Dichloroethene	$3.312 \times 10^{-4}$	1.47	$1.23 \times 10^{-1}$
1,2-Dichloropropane	$8.640 \times 10^{-3}$	$3.84 \times 10^{-1}$	$3.20 \times 10^{-2}$
Ethyl Benzene	$5.904 \times 10^{-4}$	2.62	$2.19 \times 10^{-1}$
2-Hexanone (methyl butyl ketone)	$1.008 \times 10^{-3}$	4.48	$3.73 \times 10^{-1}$
4-Methyl-2-pentanone (methyl isobutyl ketone)	$1.584 \times 10^{-3}$	1.54	$1.28 \times 10^{-1}$
Tetrachloroethene	$4.32 \times 10^{-3}$	$1.92 \times 10^{-1}$	$1.60 \times 10^{-2}$
Toluene	$8.352 \times 10^{-3}$	37.09	3.09
Trichloroethene	$4.032 \times 10^{-4}$	1.79	$1.49 \times 10^{-1}$
Xylenes (total)	$1.728 \times 10^{-3}$	7.67	$6.40 \times 10^{-1}$
Vinyl chloride	$4.464 \times 10^{-3}$	19.83	1.65

Notes:

PCOC = Potential Contaminant of Concern  
g/s = grams per second  
 $\mu\text{g}/\text{m}^3$  = micrograms per cubic meter

<sup>1</sup>This is the 24-hour time weighted average of a 2-hour irrigation period generating 1-hour maximum air concentrations.

Table 6-4 Equations Used To Calculate Doses for Each Exposure Route

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Daily Intake via Ingestion of Spray Water or Pool Water During Swimming:

$$\text{Intake (mg/kg/day)} = \frac{C_w \times IR \times EF \times ED \times ET}{BW \times AT}$$

where

$C_w$  Chemical concentration in water (mg/l)  
 $IR$  Daily water ingestion (l/day)  
 $EF_s$  Exposure frequency, spray (days/year) or  
 $EF_p$  Exposure frequency, pool (days/year)  
 $ED$  Exposure duration (years)  
 $ET_s$  Exposure time, spray (hours/day) or  
 $ET_p$  Exposure time, pool (hours/day)  
 $BW$  Body weight (kg)  
 $AT$  Averaging time (days)

Absorbed Dose via Dermal Contact with Spray Water or Pool Water While Swimming:

$$\text{Absorbed Dose (mg/kg/day)} = \frac{C_w \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

where

$C_w$  Chemical concentration in water (mg/l)  
 $SA_s$  Exposed surface area, spray (cm<sup>2</sup>) or  
 $SA_p$  Exposed surface area, pool (cm<sup>2</sup>)  
 $PC$  Permeability constant, chemical-specific (cm/hour)  
 $ET_s$  Exposure time, spray (hours/day) or  
 $ET_p$  Exposure time, pool (hours/day)  
 $EF_s$  Exposure frequency, spray (days/year) or  
 $EF_p$  Exposure frequency, pool (days/year)  
 $ED$  Exposure duration (years)  
 $CF$  Correction factor (l/cm<sup>3</sup>)  
 $BW$  Body weight (kg)  
 $AT$  Averaging time (days)

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See notes at end of table.

Table 6-4 (continued) Equations Used To Calculate Doses for Each Exposure Route

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Daily Intake via Inhalation of Vapors from Spray Water:

$$\text{Intake (mg/kg/day)} = \frac{C_a \times IR \times ET \times EF \times ED}{BW \times AT}$$

where

$C_a$  Chemical specific 24-hour average air concentration ( $\text{m}^3/\ell$ )  
IR Inhalation rate ( $\text{m}^3/\text{hour}$ )  
EF Exposure frequency, spray (days/year)  
ED Exposure duration (years)  
ET Exposure time, spray 24-hour (hours/day)  
BW Body weight (kg)  
AT Averaging time (days)

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Notes: mg/l = milligrams per liter.  
kg = kilograms.  
cm/hour = centimeters per hour.  
 $\text{m}^3/\ell$  = cubic meters per liter.  
hours/day = hours per day.  
 $\text{cm}^2$  = square centimeters.  
 $\text{L}/\text{cm}^3$  = liters per cubic centimeter.  
 $\text{m}^3/\text{hour}$  = cubic meters per hour.  
days/year = days per year.  
L/day = liters per day.  
mg/kg/day = milligrams per kilogram per day

Table 6-5 The Exposure Factors Used To Calculate Doses for Each Exposure Route and Exposure Scenario

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Daily Intake via Ingestion of Spray Water (Maximum Possible Exposure):

C <sub>w</sub>	Chemical concentration in water;	Chemical-specific, mg/l; 100% of EPC for each chemical
IR	Hourly water ingestion	0.05 l/hr
EF	Exposure frequency, spray	350 days/year
ED	Exposure duration	3 years for adults and children 6 years for children 30 years for adults
ET	Exposure time, spray	2 hours/day
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

Intake via Ingestion of Pool Water During Swimming (Maximum Possible Exposure):

C <sub>w</sub>	Chemical concentration in water	Chemical-specific, mg/l; 100% of EPC for each chemical
IR	Hourly water ingestion	0.05 l/hr
EF	Exposure frequency	88 days/year
ED	Exposure duration	3 years for adults and children 6 years for children 30 years for adults
ET	Exposure time	4 hours/day
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

Daily Intake via Ingestion of Spray Water (Maximum Likely Exposure):

C <sub>w</sub>	Chemical concentration in water	Chemical-specific, mg/l; 10% of EPC for each chemical
IR	Hourly water ingestion	0.05 l/hr
EF	Exposure frequency	350 days/year
ED	Exposure duration	3 years for adults and children 6 years for children 30 years for adults
ET	Exposure time	0.167 hours/day
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

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See notes at end of table.

Table 6-5 (continued) The Exposure Factors Used To Calculate Doses for Each Exposure Route and Exposure Scenario

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Daily Intake via Ingestion of Pool Water During Swimming (Maximum Likely Exposure):

C <sub>w</sub>	Chemical concentration in water	Chemical-specific, mg/l adults: 10 percent EPC except vinyl chloride zero (0) percent children: 100 percent EPC except vinyl chloride 50 percent
IR	Hourly water ingestion	0.05 l/hr
EF	Exposure frequency	88 days/year
ED	Exposure duration	3 years for adults and children 6 years for children 30 years for adults
ET	Exposure time	4 hours/day
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

Daily Intake via Inhalation of Vapors from Spray Water (Maximum Possible Exposure Scenario):

C <sub>a</sub>	Chemical concentration in air	Chemical-specific, mg/l; 100 percent volatilization of EPC concentration from groundwater into air
IR	Inhalation rate	0.833 m <sup>3</sup> /hour
EF	Exposure frequency	350 days/year
ED	Exposure duration	3 years for adults and children 6 years for children 30 years for adults
ET	Exposure time	24 hours/day
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

Daily Intake via Inhalation of Vapors from Spray Water (Maximum Likely Exposure Scenario):

C <sub>a</sub>	Chemical concentration in air	Chemical-specific, mg/l; 90 percent volatilization of EPC concentration from groundwater into air
IR	Inhalation rate	0.833 m <sup>3</sup> /hour
EF	Exposure frequency	350 days/year
ED	Exposure duration	3 years for adults and children 6 years for children 30 years for adults
ET	Exposure time	24 hours/day for
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

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See notes at end of table.

Table 6-5 (continued) The Exposure Factors Used To Calculate Doses for Each Exposure Route and Exposure Scenario

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Absorbed Dose via Dermal Contact with Spray Water (Maximum Possible Exposure):

SA	Exposed surface area	1,990 cm <sup>2</sup> for children 5,300 cm <sup>2</sup> for adults
PC	Permeability constant	Chemical-specific, cm/hour;
	Benzene	1.1x10 <sup>-1</sup>
	2-Butanone	5.0x10 <sup>-1</sup>
	Chlorobenzene	4.1x10 <sup>-2</sup>
	1,4-Dichlorobenzene	6.2x10 <sup>-2</sup>
	1,1-Dichloroethane	8.9x10 <sup>-3</sup>
	1,2-Dichloroethane	5.3x10 <sup>-3</sup>
	cis-1,2-Dichloroethene	1.0x10 <sup>-2</sup>
	trans-1,2-Dichloroethene	1.0x10 <sup>-2</sup>
	1,2-Dichloropropane	1.0x10 <sup>-2</sup>
	Ethylbenzene	1.0
	2-Hexanone (MBK)	9.5x10 <sup>-2</sup>
	4-Methyl-2-pentanone (MIBK)	8.3x10 <sup>-2</sup>
	Tetrachloroethene	3.7x10 <sup>-1</sup>
	Toluene	1.0
	Trichloroethene	2.3x10 <sup>-1</sup>
	Xylenes (total)	8.0x10 <sup>-2</sup>
	Vinyl chloride	7.3x10 <sup>-1</sup>
C <sub>w</sub>	Chemical concentration in water	Chemical-specific, mg/l; 100 percent of EPC for each chemical
ET	Exposure time	2 hours/day
EF	Exposure frequency	350 days/year
ED	Exposure duration (years)	3 years for adults and children 6 years for children 30 years for adults
CF	Correction factor	0.001 l/cm <sup>3</sup>
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

Absorbed Dose via Dermal Contact with Spray Water (Maximum Likely Exposure):

SA <sub>s</sub>	Exposed surface area, spray	1,990 cm <sup>2</sup> for children 5,300 cm <sup>2</sup> for adults
PC	Permeability constant	Chemical-specific, cm/hour; See above
C <sub>w</sub>	Chemical concentration in water	Chemical-specific, mg/l; 10 percent of EPC of each chemical
ET	Exposure time	0.167 hours/day
EF	Exposure frequency	350 days/year
ED	Exposure duration	3 years for adults and children 6 years for children 30 years for adults
CF	Correction factor	0.001 L/cm <sup>3</sup>
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

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See notes at end of table.

Table 6-5 (continued) Exposure Factors Used To Calculate Doses for Each Exposure Route and Exposure Scenario

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Absorbed Dose via Dermal Contact While Swimming (Maximum Possible Exposure):

SA <sub>p</sub>	Exposed surface area, pool	7,280 cm <sup>2</sup> for children 19,400 cm <sup>2</sup> for adults
PC	Permeability constant	Chemical-specific, cm/hour; See above
ED	Exposure duration	3 years for adults and children 6 years for children 30 years for adults
C <sub>w</sub>	Chemical concentration in water	Chemical-specific, mg/l; 100 percent of EPC for each chemical
EF	Exposure Frequency	88 days/year
ET	Exposure time	4 hours/day
CF	Correction factor	0.001 l/cm <sup>3</sup>
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

Absorbed Dose via Dermal Contact While Swimming (Maximum Likely Exposure):

SA <sub>p</sub>	Exposed surface area, pool	7,280 cm <sup>2</sup> for children 19,400 cm <sup>2</sup> for adults
PC	Permeability constant	Chemical-specific, cm/hour; See above
ED	Exposure duration	3 years for adults and children 6 years for children 30 years for adults
C <sub>w</sub>	Chemical concentration in water	Chemical-specific, mg/l; adults: 10 percent EPC except vinyl chloride zero (0) percent; children: 100 percent EPC except vinyl chloride 50 percent
EF	Exposure Frequency	88 days/year
ET	Exposure time	4 hours/day
CF	Correction factor	0.001 l/cm <sup>3</sup>
BW	Body weight	15 kg for children 70 kg for adults
AT	Averaging time	25,550 days for cancer effects ED x 365 days/yr for non-cancer effects

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Notes: mg/l = milligrams per liter.  
days/year = days per year.  
kg = kilograms.  
cm/hour = centimeters per hour.  
m<sup>3</sup>/l = cubic meters per liter.  
cm<sup>2</sup> = square centimeters.  
hours/day = hours per day.

Table 6-6 provides the oral and inhalation CSFs for each PCOC at the site. In addition to the CSFs, information concerning the toxicological studies that these values are based upon including species, duration of study, target organ, and source of the information are also provided.

Table 6-7 provides the oral and inhalation chronic and subchronic RfDs for all of the non-carcinogenic PCOCs at the site. Also provided are uncertainty factor, confidence level, and source of the information. Table 6-8 provides a brief summary of known toxicological effects by major organ system of the PCOCs at the site. The information in Table 6-8 is qualitative in nature and does not provide dose-response information on these effects. It does, however, provide the reader with a quick overview of the potential toxicity associated with human exposure to the PCOCs.

The sources of toxicity and dose-response information used in this risk assessment are the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1992c; 1993). IRIS and HEAST contain descriptive and quantitative toxicity information and are the two most authoritative sources of verified USEPA dose-response values. All toxicity values for the PCOCs in the SRE were obtained from IRIS or HEAST except those for trichloroethene, tetrachloroethene, which were obtained from USEPA Region IV, and for 2-hexanone, which was derived for ABB-ES by the USEPA Environmental Criteria Assessment Office in 1991.

**6.5 RISK CHARACTERIZATION.** The risk characterization phase of the SRE uses both the doses of each PCOC calculated in the exposure assessment and the toxicity data provided in the toxicity assessment to estimate the risks associated with exposure to the PCOCs at the site. As previously noted, carcinogenic risks are characterized differently than are non-carcinogenic risks.

**6.5.1 Carcinogenic Risks.** Carcinogenic risks are determined by multiplying the LADD for each carcinogen by each route by its CSF for that route in the equation:

$$Risk = CSF \times LADD$$

Risk	=	the probability of developing a carcinogenic response above the background rate (unitless),
CSF	=	the Cancer Slope Factor in (mg/kg/day) <sup>-1</sup> , and
LADD	=	the Lifetime Average Daily Dose (mg/kg/day).

The results of this equation is a probability of developing a carcinogenic response above the background incidence. Those PCOCs that are proven to be carcinogenic in man, Weight of Evidence Class A, are benzene and vinyl chloride (Table 6-6). Those PCOCs suspected to be carcinogenic in man but proven to be carcinogenic in at least one species of test animals, Weight of Evidence Classes B and C, are 1,2-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloropropane, tetrachloroethene, and trichloroethene (Table 6-6). These CSFs are often the upper 95 percentile confidence limit of the probability of a response based on experimental data. As such, the carcinogenic risk estimates presented in this

Table 6-6 Carcinogenic Toxicity Factors For the PCOCs Identified in the Groundwater at the Crooked River Plantation Subdivision

Chemical	WOE Class	Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Inhalation Slope Factor (mg/kg/day) <sup>-1</sup>	Species, Exposure Route, Duration, Target Organ	Source
Benzene	A	2.9x10 <sup>-2</sup>	2.9x10 <sup>-2</sup>	Human, inhalation, occupational, leukemia	IRIS
2-Butanone	D	--	--	--	IRIS
Chlorobenzene	D	--	--	--	IRIS
1,2-Dichlorobenzene	C	2.4x10 <sup>-2</sup>	--	Mouse, gavage, 103 weeks, liver tumors	HEAST (1992)
1,1-Dichloroethane	C	--	--	--	IRIS
1,2-Dichloroethane	B2	9.2x10 <sup>-1</sup>	9.2x10 <sup>-1</sup>	Rat, gavage, 78 weeks, circulatory system sarcomas	IRIS
cis-1,2-Dichloroethene	D	--	--	--	IRIS
trans-1,2-Dichloroethene		--	--	--	--
1,2-Dichloropropane	B2	6.8x10 <sup>-2</sup>	--	Mouse, gavage, liver tumors	HEAST (1992)
Ethyl benzene	D	--	--	--	IRIS
2-Hexanone (methyl butyl ketone)		--	--	--	--
4-Methyl-2-pentanone (methyl isobutyl ketone)		--	--	--	--
Tetrachloroethene	B2	5.1x10 <sup>-2</sup>		Mouse, gavage, liver tumors	HEAST (1991)
			1.8x10 <sup>-3</sup>	Rat and mouse, inhalation, leukemia and liver tumors	HEAST (1991)
Toluene	D	--	--	--	IRIS
Trichloroethene	B2	1.1x10 <sup>-2</sup>		Mouse, gavage, liver tumors	HEAST (1991)
			6.0x10 <sup>-3</sup>	Mouse, inhalation, lung tumors	HEAST (1991)
Xylenes (mixed)	D	--	--	--	IRIS
Vinyl chloride	A	1.9		Rat, oral, 1001 days, lung and liver tumors	HEAST (1992)
			3.0x10 <sup>-1</sup>	Rat, inhalation, 1 year, liver tumors	HEAST (1992)

Notes: WOE = Weight of Evidence.

Class

- A Human carcinogen - Sufficient evidence from epidemiological studies to support a causal association between exposure and cancer.
- B1 Probable human carcinogen - Limited evidence of carcinogenicity in humans from epidemiological studies.
- B2 Probable human carcinogen - Sufficient evidence of carcinogenicity in animals, inadequate evidence of carcinogenicity in humans.
- C Possible human carcinogen - Limited evidence of carcinogenicity in animals.
- D Not classified - Inadequate evidence of carcinogenicity in animals.

(mg/kg/day)<sup>-1</sup> = per milligram per kilogram per day.

HEAST = Health Effects Assessment Summary Tables.

IRIS = Integrated Risk Information System (1993).

Table 6-7 Non-Carcinogenic Toxicity Factors For the Contaminants in the Groundwater at the Crooked River Plantation Subdivision

Chemical	Oral Chronic RfD (mg/kg/day)	Inhalation Chronic RfD (mg/kg/day)	Oral Subchronic RfD (mg/kg/day)	Inhalation Subchronic RfD (mg/kg/day)	Confidence Level, Uncertainty Factors	Source
Benzene	--	--			--	--
2-Butanone	5x10 <sup>2</sup>		5x10 <sup>1</sup>		UF = 1000	HEAST (1992)
		9x10 <sup>2</sup>		9x10 <sup>1</sup>	UF = 1000	HEAST (1992)
Chlorobenzene	2x10 <sup>2</sup>		2x10 <sup>1</sup>		Medium UF = 1000	IRIS HEAST (1992)
		5x10 <sup>2</sup>		5x10 <sup>2</sup>	UF = 10000	HEAST (1992)
1,4-Dichlorobenzene	--		--		UF = 100	HEAST (1991)
		2x10 <sup>1</sup>		--	UF = 100	HEAST (1991)
1,1-Dichloroethane	1x10 <sup>1</sup>				UF = 1000	HEAST (1992)
		1x10 <sup>1</sup>			UF = 1000	HEAST (1992)
1,2-Dichloroethane	--	--	--	--	--	--
cis-1,2-Dichloroethene	1x10 <sup>2</sup>	--	1x10 <sup>1</sup>	--	UF = 3000 UF = 300	HEAST (1992)
trans-1,2-Dichloroethene	2x10 <sup>2</sup>	--	2x10 <sup>1</sup>	--	Low UF = 1000 UF = 100	IRIS HEAST (1992)
1,2-Dichloropropane	--	1x10 <sup>1</sup>	--	1x10 <sup>2</sup>	Medium UF = 300 UF = 100	IRIS HEAST (1992)
Ethyl benzene	1x10 <sup>1</sup>		1		Low UF = 1000 UF = 100	IRIS HEAST (1992)
		3x10 <sup>1</sup>		3x10 <sup>1</sup>	UF = 300	IRIS HEAST (1992)
2-Hexanone (methyl butyl ketone)	4x10 <sup>2</sup>	4x10 <sup>2</sup>			UF = 10000	SHRTC (1992)

See notes at end of table.

Table 6-7 (continued) Non-Carcinogenic Toxicity Factors For the Contaminants in the Groundwater at the Crooked River Plantation Subdivision

Chemical	Oral Chronic RfD (mg/kg/day)	Inhalation Chronic RfD (mg/kg/day)	Oral Subchronic RfD (mg/kg/day)	Inhalation Subchronic RfD (mg/kg/day)	Confidence Level, Uncertainty Factors	Source
4-Methyl-2-pentanone (methyl isobutyl ketone)	5x10 <sup>-3</sup>		5x10 <sup>-1</sup>		UF = 1000 UF = 100	HEAST (1992)
		2x10 <sup>-3</sup>		2x10 <sup>-1</sup>	UF = 1000 UF = 100	HEAST (1992)
Tetrachloroethene	1x10 <sup>-3</sup>	--	1x10 <sup>-1</sup>		Medium UF = 1000	IRIS HEAST (1992)
Toluene	2x10 <sup>-1</sup>		2		Medium UF = 1000 UF = 100	IRIS HEAST (1992)
		1x10 <sup>-3</sup>			UF = 300	HEAST (1992)
Trichloroethene	6x10 <sup>-3</sup>	--			--	Region IV
Xylenes (mixed)	2		4		Medium UF = 100	IRIS
		6x10 <sup>-1</sup>			UF = 100	HEAST (1992)
Vinyl chloride	--	--			--	--

Notes: RfD = Reference Dose  
mg/kg/day = milligram per kilogram per day.  
UF = Uncertainty Factor.  
HEAST = Health Effects Assessment Summary Tables.  
IRIS = Integrated Risk Information System.  
SHRTC = Superfund Health Risk Technical Center.  
Region IV = Specific Guidance from U.S. Environmental Protection Agency Region IV.

Table 6-8 Toxicology Information of the PCOCs Identified in the Groundwater

Chemical Name	Resp	Cardio	Hemat	Hepatic	Renal	Dermal/Ocular	Immuno	Neurol	Develop	Repro	Geno
Benzene	-	-	+	-	-	-	+	+	-	-	+
2-Butanone (MEK)	-	-	-	-	-	-	-	+	+	-	-
Chlorobenzene	-	-	-	-	-	+	-	+	-	-	-
1,4-Dichlorobenzene	+	-	-	+	+	+	+	+	-	-	-
1,1-Dichloroethane	-	-	-	+	+	-	-	-	-	-	-
1,2-Dichloroethane	+	+	-	+	+	+	+	+	-	+	+
cis 1,2-Dichloroethene	-	-	+	+	-	-	-	-	ND	ND	-
trans 1,2-Dichloroethene	-	-	-	+	-	-	-	-	ND	ND	-
1,2-Dichloropropane	+	+	-	+	+	+	ND	+	ND	ND	ND
Ethyl benzene	+	-	-	+	+	+	ND	+	+	-	-
2-Hexanone (MBK)	-	-	-	-	-	-	ND	+	-	+	-
4-Methyl-2-pentanone (MIBK)	-	-	-	+	+	-	-	+	-	-	-
Tetrachloroethene	+	+	-	+	+	+	+	+	-	-	-
Toluene	+	-	+	+	+	-	+	+	+	-	-
Trichloroethene	ND	-	-	-	-	+	+	+	-	-	+/-
Xylene (total)	+	-	-	+	+	+	-	+	-	-	-
Vinyl chloride	+	+	+	+	+	+	+	+	+	+	+

Notes:

Sources for this information include ATSDR Toxicology profiles for these contaminants.

Abbreviations:

(+) = Toxicity to this organ system has been observed in animals or humans exposed to this contaminant.

(-) = Toxicity to this organ system has not been observed in animals or humans exposed to this contaminant.

Resp = Respiratory  
 Cardio = Cardiovascular  
 Hemat = Hematological  
 Immuno = Immunological  
 Neurol = Neurological

Develop = Developmental  
 Repro = Reproductive  
 Geno = Genotoxic  
 +/- = inconclusive data  
 ND = no data

subsection are considered to be an upper-bound estimate of risk. The "true risk" to an individual is likely to be less than these estimates predict (USEPA, 1989a). Table 6-6 also shows that some PCOCs may be carcinogenic by one route, i.e., ingestion, but not by another and that some PCOCs have different CSFs for different exposure routes.

As previously noted, the USEPA has established criteria for interpreting carcinogenic risk estimates calculated by the standard USEPA risk evaluation methodology used in the SRE. This guidance states that an acceptable range of lifetime upper-bound excess cancer risk is from  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  (NCP, 1990). In this SRE a maximum possible exposure scenario was first examined to determine if risks were present at the site in the  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  risk range. If risks above this range were detected, then a more reasonable, maximum likely exposure scenario was also examined to determine if the risks at the site still exceeded this risk range.

**6.5.2 Non-Carcinogenic Risks** Non-carcinogenic risks are not expressed as a probability of an adverse effect occurring in an individual. Rather, non-carcinogenic risks are estimated by dividing the average daily dose (ADD) for each contaminant by the appropriate RfD. The resulting ratio for each chemical is called a Hazard Quotient (HQ). The sum of all of the HQs by all exposure pathways is called the Hazard Index (HI). The formula for calculating an HQ is:

$$HQ = \frac{ADD}{RfD}$$

HQ	=	Hazard Quotient (unitless),
ADD	=	Average Daily Dose (mg/kg/day), and
RfD	=	Reference Dose (mg/kg/day).

The RfDs are mainly based upon the lowest doses that toxicological effects were observed in an animal or human study with an uncertainty factor applied. However, as Tables 6-7 and 6-8 show, the known non-carcinogenic toxicological effects of the PCOCs at the site can be quite diverse and the non-carcinogenic effects associated with PCOC exposure can occur in a variety of different organ systems.

However, non-carcinogenic toxic effects are believed to have a threshold dose below which no adverse effect is expected and the USEPA has established guidelines for interpreting hazard index (HI) calculations calculated by the standard risk evaluation methodology used in the SRE (USEPA, 1989a). This guidance states that an HQ is calculated for each PCOC by each exposure pathway and then the HQs are summed to calculate the HI. If the HI exceeds 1.0 then there may be concern for potential non-carcinogenic health effects (USEPA, 1989a). In this case additional analyses are required to determine what organ system(s) might be the site of a possible toxic response.

USEPA Region IV has provided unusual guidance for calculating subchronic HQs and HIs in this SRE. This guidance is to use chronic RfDs in place of subchronic RfDs for exposures in children. This guidance is contrary to other USEPA guidance for risk assessment but it was followed in this analysis (USEPA, 1989a). Because subchronic RfDs are usually, but not always, 10 times lower than chronic RfDs, the impact of this guidance is that the HQs and HIs calculated for the

child exposures are 10 times higher than they would be if the standard USEPA guidance were to be followed.

**6.5.3 Carcinogenic Risks for the Maximum Possible Exposure Scenario** The total carcinogenic risk for the 3-year child resident was  $4 \times 10^{-4}$ , which exceeds the upper end of the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  acceptable risk range. Almost 98 percent of this risk is due to vinyl chloride via the dermal exposure and incidental ingestion routes of exposure. No other dermal or incidental ingestion risks were greater than  $1 \times 10^{-6}$ . No risks due to inhalation exposure to any PCOC, including vinyl chloride, were greater than  $3 \times 10^{-8}$  indicating that the inhalation pathway may not be a significant exposure pathway for PCOCs released from the groundwater.

Similar results were found for the 6-year child exposure. The total carcinogenic risk was  $8 \times 10^{-4}$  with over 98 percent of the risk coming from vinyl chloride. Over 35 percent of the vinyl chloride risk was due to dermal contact with the other 64 percent due to incidental ingestion. No inhalation risks were greater than  $1 \times 10^{-6}$ .

The 3-year adult exposure, total risk of  $1 \times 10^{-4}$ , also had carcinogenic risks at the upper bound of the acceptable range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  (Table 6-9). Again this was almost completely due to vinyl chloride by the dermal and incidental ingestion routes of exposure (Table 6-10).

The greatest total carcinogenic risk in all of the SRE exposure scenarios was  $1 \times 10^{-3}$  for the 30-year adult exposure (Table 6-9). This risk was almost 98 percent due to vinyl chloride exposure (Table 6-10). Dermal absorption accounted for 58 percent of the vinyl chloride risk with incidental ingestion accounting for another 30 percent of the risk.

**6.5.4 Non-Carcinogenic Risks for the Maximum Possible Scenario** Table 6-11 provides the total HIs resulting from exposure to the PCOCs at the site for both adults and children. The HIs are broken down by exposure pathway in Table 6-12.

The total HI for the maximum possible exposure to the groundwater for the 3- and 6-year old child exposure indicates that there is concern for the potential for non-carcinogenic health effects occur if the groundwater were to be used for the purposes described in the exposure assessment (Table 6-11).

The total HQ for these exposure scenarios were 10.6 with almost 58 percent of this effect due to cis-1,2-dichloroethene and 20 percent due to toluene (Table 6-12). The cis-1,2-dichloroethene HI was almost 57 percent due to incidental ingestion with the remaining 43 percent due to dermal absorption. Toluene also showed an HI above 1.0 with 99 percent of this value due to dermal absorption. The potential for non-carcinogenic effects due to inhalation exposure does not appear to be of concern since the HI for this route of exposure is much less than 1.0.

If non-carcinogenic effects were to occur, the organ systems that might be include the nervous system, the liver (hepatic), kidney, and the hematopoietic

Table 6-9 Lifetime Total Maximum Upper-Bound Carcinogenic Risks Associated with Exposure to the Contaminants Identified in the Groundwater at Crooked River Plantation Subdivision

Human Receptor	3 Years	6 Years	30 Years
Child resident (Maximum Possible Exposure Exposure)	4x10 <sup>-4</sup>	8x10 <sup>-4</sup>	-
Adult resident (Maximum Possible Exposure Exposure)	1x10 <sup>-4</sup>	-	1x10 <sup>-3</sup>

Note: - = not calculated.

Table 6-10 Lifetime Total Maximum Upper-Bound Carcinogenic Risks by Exposure Route Associated with the Maximum Possible Exposure to the PCOCs Identified in the Groundwater at Crooked River Plantation Subdivision

Human Receptor	3 Year			6 Year			30 Year		
	Inhal	Dermal	Ingest	Inhal	Dermal	Ingest	Inhal	Dermal	Ingest
Child resident (Maximum Possible Exposure Exposure)	3x10 <sup>-4</sup>	1x10 <sup>-4</sup>	2x10 <sup>-4</sup>	6x10 <sup>-4</sup>	3x10 <sup>-4</sup>	5x10 <sup>-4</sup>	-	-	-
Adult resident (Maximum Possible Exposure Exposure)	6x10 <sup>-3</sup>	8x10 <sup>-3</sup>	5x10 <sup>-3</sup>	-	-	-	6x10 <sup>-3</sup>	8x10 <sup>-3</sup>	5x10 <sup>-3</sup>

Notes:

- = not calculated.

Inhal = Inhalation Exposure

Dermal = Dermal Absorption

Ingest = Incidental Ingestion

Table 6-11 Total Hazard Quotient Associated with the Maximum Possible Exposure to the PCOCs Identified in the Groundwater at Crooked River Plantation Subdivision

Human Receptor	3 Years	6 Years	30 Years
Child (Maximum Possible Exposure)	10.5	10.5	-
Adult (Maximum Possible Exposure)	4.6	-	4.6

Note:

- = not calculated.

Table 6-12 Total Hazard Quotient by Exposure Route Associated with Exposure to the Contaminants Identified in the Groundwater at Crooked River Plantation Subdivision

Human Receptor	3 Year			6 Year			30 Year		
	Inhal	Dermal	Ingest	Inhal	Dermal	Ingest	Inhal	Dermal	Ingest
Child resident (Maximum Possible Exposure)	0.0002	6.7	3.8	0.0002	6.7	3.8	-	-	-
Adult resident (Maximum Possible Exposure)	0.00004	3.8	0.8	-	-	-	0.00004	3.8	0.8

Notes:

- = not calculated.

Inhal = Inhalation Exposure

Dermal = Dermal Absorption

Ingest = Incidental Ingestion

(blood) system. Possible non-carcinogenic toxic effects on the immunological system, the skin and eyes (dermal/ocular), and lungs (respiratory) might also occur.

It should be noted that the risk estimates presented in this exposure scenario were used as an initial screen to determine if any significant risks were present at the site regardless of the practicality of the exposure scenario. However, as shown above, the carcinogenic risks are above the acceptable risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  whereas the HIs, using the chronic RfDs rather than the subchronic RfDs for children, indicate a potential for non-carcinogenic health effects. Therefore, the risks associated with a more reasonable, maximum likely exposure scenario were also calculated to determine if unacceptable risks were present under a more realistic exposure scenario.

**6.5.5 Carcinogenic Risks for the Maximum Likely Exposure Scenario** In contrast to the maximum possible exposure scenario, the carcinogenic risks associated with the maximum likely exposure scenario were much lower (Tables 6-13 and 6-14). The total carcinogenic risk of the 3-year child exposure was within the acceptable range at  $9 \times 10^{-5}$  with 94 percent of the risk due to vinyl chloride exposure. The vinyl chloride risks were equally split between incidental ingestion and dermal absorption. No other risks were above  $1 \times 10^{-6}$ .

The carcinogenic risk in the 6-year child exposure was slightly above the upper end of the acceptable risk range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  with a total risk of  $2 \times 10^{-4}$  (Table 6-14). Again, almost 95 percent of the risk was due to vinyl chloride exposure (Table 6-15). The vinyl chloride risk was split evenly between ingestion and dermal absorption.

The carcinogenic risks of the 3- and 30-year adult exposure were within the acceptable risk range with a maximum risk of  $3 \times 10^{-6}$ . No one PCOC showed a risk greater than  $1 \times 10^{-6}$  by any route of exposure.

**6.5.6 Non-Carcinogenic Risks for the Maximum Likely Exposure Scenario** These results indicate that non-carcinogenic toxic effects on several organ system may occur in children if exposure was to occur in a manner similar to that described in subsection 6.3.3 (Table 6-15). However, if the standard USEPA risk assessment guidance to use subchronic RfDs in a subchronic exposure situation were to be followed, then none of the HQs or HIs would be above 1.0.

None of the HIs or HQs calculated for the adults were greater than 1.0. This indicates that no non-carcinogenic effects are for adults expected due to exposure to the groundwater (Table 6-15).

The total HI, using the chronic RfD rather than the subchronic RfD, for the reasonable case exposure to the groundwater for the 3- and 6-year old child exposure suggests concern for the potential for non-carcinogenic health effects could occur if the groundwater were to be used in children's wading pools or for other water play devices (Table 6-15). The total HI for these exposure scenarios was 5.6 with 51 percent of the risk due to cis-1,2-dichloroethene and 24 percent due to toluene (Table 6-16). The risks from cis-1,2-dichloroethene were evenly divided at 60 percent for dermal absorption and 40 percent for incidental ingestion. The toluene risk was over 99 percent due to dermal absorption (Table 6-16).

Table 6-13 Lifetime Total Maximum Upper-Bound Carcinogenic Risks Associated with the Maximum Likely Exposure to the PCOCs in the Groundwater at the Crooked River Plantation Subdivision

Human Receptor	3 Years	6 Years	30 Years
Child (Maximum Likely Exposure)	$9 \times 10^{-5}$	$2 \times 10^{-4}$	-
Adult (Maximum Likely Exposure)	$3 \times 10^{-1}$	-	$3 \times 10^{-4}$

Note: - = not calculated.

Table 6-14 Lifetime Total Maximum Upper-Bound Carcinogenic Risks by Exposure Route Associated with the Maximum Likely Exposure to the PCOCs Identified in the Groundwater at the Crooked River Plantation Subdivision

Human Receptor	3 Year			6 Year			30 Year		
	Inhal	Dermal	Ingest	Inhal	Dermal	Ingest	Inhal	Dermal	Ingest
Child resident (Maximum Likely Exposure)	$2.8 \times 10^{-4}$	$4.8 \times 10^{-5}$	$4.2 \times 10^{-5}$	$5.5 \times 10^{-4}$	$9.5 \times 10^{-5}$	$8.3 \times 10^{-5}$	-	-	-
Adult resident (Maximum Likely Exposure)	$5.9 \times 10^{-6}$	$2.5 \times 10^{-7}$	$6.9 \times 10^{-9}$	-	-	-	$5.9 \times 10^{-4}$	$2.5 \times 10^{-4}$	$6.9 \times 10^{-4}$

Notes:

- = not calculated.  
 Inhal = Inhalation Exposure  
 Dermal = Dermal Absorption  
 Ingest = Incidental Ingestion

Table 6-15 Total Hazard Index Associated with the Maximum Likely Exposure to the Contaminants Identified in the Groundwater at Crooked River Plantation Subdivision

Human Receptor	3 Years	6 Years	30 Years
Child resident (Maximum Likely Exposure)	5.6	5.6	NC
Adult resident (Maximum Likely Exposure)	0.3	NC	0.3

Note: NC = not calculated.

Table 6-16 Total Hazard Quotient by Exposure Route Associated with the Maximum Likely Exposure to the PCOCs Identified in the Groundwater at Crooked River Plantation Subdivision

Human Receptor	3 Year			6 Year			30 Year		
	Inhal	Dermal	Ingest	Inhal	Dermal	Ingest	Inhal	Dermal	Ingest
Child resident (Maximum Likely Exposure)	0.0002	4.4	1.3	.0002	4.4	1.3			
Adult resident (Maximum Likely Exposure)	0.00004	0.25	0.028	-	-	-	0.00004	0.25	0.028

Notes:

- = not calculated.

Inhal = Inhalation Exposure

Dermal = Dermal Absorption

Ingest = Incidental Ingestion

Based upon the HQs in this exposure scenario, the potentiation interaction between 2-hexanone (methyl butyl ketone) and 2-butanone (methyl ethyl ketone) is not believed likely to occur. The sum of the HQs for these two contaminants multiplied by a factor of 10 to account for possible potentiation was less than 1.0 (Appendix I).

Based upon the toxicological information in Tables 6-7 and 6-8, if non-carcinogenic effects were to occur, the possible affected organ systems include the nervous system, the liver (hepatic), the kidney, and the hematopoietic (blood) system. Other possible target organ include the immunological system, the skin and eyes (dermal/ocular), and lungs (respiratory).

The potentiation interaction between 2-hexanone (methyl butyl ketone) and 2-butanone (methyl ethyl ketone) was also a toxic effect considered in this analysis. However, the sum of the HQs of these two PCOCs, with a multiplicative factor of 10, indicates that there was no evidence that this interaction would to occur in the present exposure scenarios (Appendix I).

There are several uncertainties in this analysis that may lead to overly conservative estimates of non-carcinogenic risks. The exposure scenarios for the swimming pool exposures are different between the child resident and the adult resident. Thus, the difference between the HQs calculated for the children and the adults can be attributed to the differences in the PCOC concentrations in the water used to calculate the HIs and HQs for incidental ingestion and dermal absorption during swimming activity.

**6.6 UNCERTAINTY ANALYSIS.** The risk estimates presented in this document are based upon the standard USEPA methodology developed for analyzing both carcinogenic and non-carcinogenic risks at hazardous waste sites (USEPA, 1989a; 1990c; 1991d). This methodology relies upon a number of conservative assumptions, each with its own level of uncertainty. Those uncertainties can be grouped into five broad categories:

- the assumptions concerning the exposure scenarios,
- the population of human receptors exposed to the contaminants,
- the toxicity assessment of the contaminants,
- the air modeling used to calculate the air concentrations, and
- the PCOC concentrations used in the risk analysis.

**6.6.1 Exposure Scenarios** The assumptions used in the exposure scenarios may not be indicative of the actual exposure conditions at the site. This is especially true for the maximum possible exposure scenario but may also be true for the maximum likely exposure scenario as well. The assumption that the irrigation systems are used 350 days a year is probably an overestimate. The assumption that people will be exposed to the spray 350 days per year is certainly an excessive overestimate because factors such as inclement weather and cold weather will tend to discourage people from coming into contact with the spray from the irrigation systems. Also it is unlikely that persons would be exposed to the spray from the

irrigation systems for 2 hours per day for 350 days per year. Therefore, the assumptions used in the exposure scenarios will overestimate the actual risks at the site. The assumptions for the maximum possible exposure scenario probably grossly overestimate the actual risks at the site.

**6.6.2 Population of Receptors** The assumptions concerning the population of human receptors exposed to the contaminants are also a source of uncertainty. Almost every population, including that in the Crooked River Plantation Subdivision, is a heterogeneous group made up of old and young people, with different body weights, body surface areas, and other physiological factors such as inhalation rates. Portions of the population may also be unusually susceptible to toxic effects due to underlying disease processes, genetic predisposition, pregnancy, or other factors. Thus, the use of a single factor for each of these parameters to represent the population in the subdivision is a source of uncertainty. It is unknown if these factors underestimate or overestimate the actual risks at the site.

**6.6.3 Toxicity Assessment, Toxicity Factors** The toxicity assessment of the contaminants at the site are another common source of uncertainty in risk assessments. The CSFs and RfDs are developed using a methodology that is filled with conservative, and not uniformly accepted, assumptions. The USEPA also has adopted a conservative approach in developing RfDs for risk evaluations. The USEPA recognizes this fact when it states "EPA is reasonably confident that the 'true risk' will not exceed the risk estimate derived through the use of this model and is likely to be less than that predicted" (USEPA, 1989a). Therefore, the actual carcinogenic risks at the site are probably overestimated.

The same is true for the HI and HQs calculated in this analysis. Using specific USEPA Region IV guidance, the HIs and HQs for the 3- and 6-year exposure scenarios in children were derived using the chronic RfDs rather than the subchronic values. This extra level of conservatism is believed to be protective against irreversible effects in growing children. However, USEPA risk assessment guidance states that subchronic RfDs, rather than chronic RfDs, should be used for exposures less than 7 years in duration (USEPA, 1989a). Because the subchronic RfDs are usually, but not always, 10 times higher than the chronic RfDs, the resulting HIs and HQs for the 3- and 6-year child exposure scenarios may be overestimates of the actual non-carcinogenic risks at the site by a factor of 10. Therefore, the non-carcinogenic risks calculated using these toxicity values are probably overestimates of the actual risks at the site.

**6.6.4 Toxicity Assessment, Potentiation and Antagonism** Areas of uncertainty not routinely covered by the toxicity factors are possible potentiation or antagonistic interactions between the PCOCs, differences in lifestyle choices among the population, and possible concomitant exposure to drugs or other chemicals. In this risk evaluation toxicological effects are considered to be additive but this methodology is inadequate for evaluating potentiation or antagonistic interactions. There is also an emerging body of scientific evidence that suggests that the assumption of additivity of carcinogenic and non-carcinogenic risks across all exposure pathways may be excessively conservative leading to gross overestimates of actual risks.

Although the potentiation between 2-hexanone (methyl butyl ketone) and 2-butanone (methyl ethyl ketone) was addressed in this document, other contaminants could also have synergistic effects with each other. Closely related chemicals can deplete the body's natural detoxification system, resulting in an exaggerated

toxicological response. On the other hand, one chemical can reduce the toxicity of a second chemical through a process called antagonism. Other factors that can influence the toxicology of a chemical include possible occupational exposure to other chemicals, concomitant exposure to prescription drugs, and lifestyle choices such as ethanol consumption and smoking. The effect of these factors on the actual risks at this site are unknown.

**6.6.5 Air Modeling** The air concentrations of the PCOCs predicted by SCREEN assume a constant wind speed of 1 meter per second with stable atmospheric conditions. These conditions will not always occur and the resulting 24-hour air concentrations predicted by SCREEN are probably higher than would be actually encountered at the site. In addition, the highest air concentrations of the PCOCs estimated by SCREEN were used to calculate the 24-hour air concentrations and the actual concentrations are probably much lower. Therefore, the risk estimates associated for the inhalation pathway to the PCOCs in this evaluation are probably overestimates of the actual risks at the site.

**6.6.6 Exposure Point Concentration** This risk analysis uses the maximum detected concentration for each PCOC as the EPC for each of the PIWs in the subdivision. Although this type of assumption is common in risk assessment, the data provided in Section 4 indicate that this is an overestimate of the actual conditions at the site. No PIW or hydrocone sample was found to contain all of the PCOCs. Further, the EPC concentrations of the PCOCs were a composite of the analytical results from three different hydrocone locations and not a single well as assumed in this analysis. Therefore, the risks calculated in this analysis are certainly overestimates of the actual risks at the site.

Also, the composition and concentration of the PCOCs in the groundwater can be expected to change over the 3- to 30-year period analyzed in this risk assessment as factors such as dilution and biotransformation occur. Therefore, the risks predicted from exposure to the PCOCs from the groundwater in this risk analysis are certainly overestimates of the current actual conditions at the site and may be excessive overestimates of future actual conditions at the site.

**6.6.7 Summary** The uncertainties associated with this SRE are summarized in Table 6-17. Almost all of the assumptions used in this risk assessment are conservative and, as such, overestimate the actual risks at the site.

The maximum possible exposure scenario certainly grossly overestimates the actual conditions at the site. The maximum likely exposure scenario also overestimates the actual human health risks at the site. However, uncertainties such as the inadequacy of the toxicity factors to describe all possible PCOC-receptor interactions and individual differences in the human population such as lifestyle, age, genetic predisposition, or underlying disease processes may need to be considered when using the results of this analysis for risk management decisions.

Table 6-17 The Effects of Various Uncertainty Factors on the Results of the Screening Risk Evaluation

Uncertainty Factor	Result of Uncertainty Factor on Risk
Exposure Scenarios	Overestimates Risk. Grossly overestimates risk for maximum possible exposure scenario.
Population of Receptors	Unknown. May overestimate risk for majority of the population but may underestimate risks for a small segment of the population.
Toxicity Assessment - Toxicity Factors	Overestimates Risk.
Toxicity Factors - Potentiation or Antagonism	Unknown. May underestimate risks in persons unusually susceptible to toxic effects due to age, genetic predisposition, underlying disease processes, or lifestyle choices.
Air Modeling	Overestimates Risk.
Exposure Point Concentration	Overestimates Risk. May grossly overestimate risk over 30 year analysis period.

## 7.0 SUMMARY and RECOMMENDATIONS

Groundwater sampling results from the Interim Corrective Measure Screening Investigation at the Old Camden County Landfill, Site 11, at NSB Kings Bay indicate that VOC contaminants are present within the surficial aquifer. Groundwater samples taken from 24 on-site and 22 off-site locations indicate that the VOC contamination is present below the site and the Crooked River Plantation Subdivision. The spatial distribution of the VOCs appears to be limited to the upper 60 feet of the surficial aquifer and the data does not suggest that the contamination extends down to the underlying Hawthorn Formation. Based on information obtained in this and previous studies, the surficial aquifer is a relatively homogeneous, water-table aquifer and consists of mostly fine sands with some silty sands and medium sands. The overall hydraulic gradient in the vicinity of the landfill is approximately 0.003 feet/feet towards the west-northwest. The VOCs appear to have migrated within the groundwater laterally toward the subdivision through advective transport and dispersion.

All but two of the contaminants detected in the groundwater were selected as potential contaminants of concern (PCOCs). Acetone and carbon disulfide were rejected because they were both detected in several rinseate blanks at comparable levels to those found in the environmental samples and they may be artifacts of sampling. In addition, carbon disulfide was rejected as a potential contaminant of concern because it is believed to be a natural background chemical.

The only identified route for human exposure to the PCOCs in the groundwater is through the use of the PIWs in the Crooked River Plantation Subdivision. The exposure pathways examined in the SRE are all linked to known or possible uses of the groundwater. Human receptors could be exposed to the PCOCs in the groundwater through the following exposure pathways:

- inhalation of the VOCs released during irrigation;
- dermal contact with the water during irrigation, washing activities, and swimming; and
- incidental ingestion of the groundwater during irrigation, washing activities, and swimming.

Unacceptable carcinogenic risks were defined as those that exceed the upper end of the carcinogenic risk range of  $10^{-6}$  to  $10^{-4}$  and non-carcinogenic risks were defined as those having Hazard Indices or Hazard Quotients greater than 1.0. Results of the SRE indicate that unacceptable risks in children and adults are associated with dermal adsorption and incidental ingestion of PCOCs in a maximum possible exposure scenario.

However, the maximum likely exposure scenario indicates carcinogenic risks are within the acceptable range. The maximum likely exposure scenario indicated that non-carcinogenic risks in children may be associated with dermal adsorption and incidental ingestion of certain PCOCs. Residents of Crooked River Plantation Subdivision should take measures to minimize these types of exposure by not using groundwater for such activities as filling swimming pools. Neither risk scenario indicates that inhalation of PCOCs causes unacceptable risks.

A Baseline Risk Assessment will be performed to assess both human health and ecological risk. The Baseline Risk Assessment will be supported by data collected from past investigations and the future Supplemental RFI.

An Interim Corrective Measure and Supplemental RFI need to be performed at Site 11 and are in the planning stage. These two additional studies will be solution-oriented programs and will be performed concurrently. The Interim Corrective Measure will take a proactive approach and will be focused on the VOC contaminated groundwater below the landfill and the subdivision. The Supplemental RFI will focus on the long-term corrective action goals and address regulatory concerns for Site 11.

The Interim Corrective Measure will include start-up activities of a groundwater extraction system and a treatment system for the VOC contaminants within the surficial aquifer. The groundwater extraction system for the start-up activities is expected to include an array of recovery wells. The treatment system for the Interim Corrective Measure is expected to be air stripping using a mobile packed tower aeration (PTA). The Interim Corrective Measure start-up activities will provide overall system operational and maintenance performance characteristics. An engineering evaluation of these data will be done. Based on the findings of the Interim Corrective Measure start-up activities and engineering evaluation, the groundwater extraction system may be enhanced with additional recovery wells or a horizontal well system. The treatment system may also be enhanced with supplemental units for long-term operation and eventual abatement of groundwater contamination.

The Supplemental RFI will be designed to support long-term CM goals. This will address the following areas where data gaps currently exist:

- waste and leachate characteristics,
- source contaminants mobility/adsorption characteristics,
- hydrogeologic conditions and hydraulic head relationships that affect the fate and transport of the contaminants,
- contamination assessment with respect to confirmation of the extent of contamination, and
- a Baseline Risk Assessment to assess both human health and ecological risk.

The Supplementary RFI and the Baseline Risk Assessment will support selection of clean-up standards in the form of environmental and health criteria. Once clean-up standards are selected, a decision will be made regarding the suitability of long-term operation of the Interim Corrective Measure or the need for a CMS. A bench-scale test may be necessary to evaluate treatability of other contaminants identified during the Supplementary RFI. Such contaminants may include SVOCs and inorganics present at concentrations above clean-up standards.

To complete the Interim Corrective Measure Screening Investigation, groundwater samples were collected from within the landfill during March 1993 using hollow-stem augering techniques and a Hydropunch™. Also, in January 1993 groundwater samples were collected from 11 PIWs, nine of which had not been sampled previously and two that were resampled. These activities are reported in an addendum to this report, included as Section 8.0.

## REFERENCES

- ABB Environmental Services, Inc. (ABB-ES), 1991. Potential Source of Contamination (PSC) Site Investigation/Solid Waste Management Unit (SI/SWMU) RCRA Facility Investigation (RFI) Work Plan Naval Submarine Base, Kings Bay, Georgia. Contract Task Order No. 030 Navy CLEAN - District 1, Contract No. N62467-89-D-0317. October.
- ABB Environmental Services, Inc. (ABB-ES), 1992a. Documentation Support and Hazard Ranking System II Scoring, Naval Submarine Base, Kings Bay, Georgia. Contract Task Order No. 061 Navy CLEAN-District 1, Contract No. N62467-89-D-0317. July.
- ABB Environmental Services, Inc. (ABB-ES), 1992b. Phase I Interim Investigation, Memorandum, Site 11, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia. September.
- ABB Environmental Services, Inc. (ABB-ES), 1992c. Technical Work Plan Interim Corrective Measure Screening Investigation - Site 11 RCRA Facility Investigation NSB, Kings Bay, Georgia. Contract Task Order No. 041 Navy CLEAN-District 1, Contract No. N62467-89-D-0317. October.
- ABB Environmental Services, Inc. (ABB-ES), 1992d. RCRA Facility Investigation/ Site Inspection Technical Memorandum No. 1, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay Georgia. Contract No. N63467-89-D-0317. June 1992.
- ABB Environmental Services, Inc. (ABB-ES), 1992e. RCRA Facility Investigation/ Site Inspection Technical Memorandum No. 2, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay Georgia. Contract No. N63467-89-D-0317. July.
- ABB Environmental Services, Inc. (ABB-ES), 1992f. RCRA Facility Investigation/ Site Inspection Technical Memorandum No. 3, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay Georgia. Contract No. N63467-89-D-0317. September.
- ABB Environmental Services, Inc. (ABB-ES), 1992g. RCRA Facility Investigation/ Site Inspection Technical Memorandum No. 4, Volume I, Site 11, Old Camden County Landfill, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay Georgia. Contract No. N63467-89-D-0317. December.
- ABB Environmental Services, Inc. (ABB-ES), 1993. RCRA Facility Investigation/ Site Inspection Technical Memorandum No. 5, Volume I, Site 11, Old Camden County Landfill, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay Georgia. Contract No. N63467-89-D-0317. March.
- Brode, R.W., 1988. Screening Procedures for Estimating the Air Quality Impact of Stationary Sources. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, August.

#### REFERENCES (continued)

- C. C. Johnson & Associates, Inc., 1985. Initial Assessment Study, Naval Energy & Environmental Support Activity, Naval Submarine Base, Kings Bay, Georgia. Contract No. N62474-84-C-3384. September.
- Cedergren, Harry R., 1989. Seepage, Drainage, and Flownets. John Wiley and Sons, New York.
- Georgia Drinking Water Standards, Rules for Safe Drinking Water, Chapter 391-3-5, Revised July 1992, Rules of Georgia Department of Natural Resources, Environmental Protection Division.
- Georgia Surface Water Criteria, Georgia Water Quality Control Specifications and Standards, The Bureau of National Affairs, Inc., August 1991.
- Gibbons, J. D., 1976. NonParametric Methods for Quantative Analysis. Holt, Rinehart and Winston, New York.
- Heartland Environmental Services, Inc., 1993. Precision, Accuracy, Representativeness, Comparability, and Completeness, NSB Kings Bay. November.
- Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Ground-Water Observations. Bulletin No. 36, Waterways Experiment Station, U.S. Army Corps of Engineers, Vicksburg, Mississippi.
- Naval Energy and Environmental Support Activity (NEESA), 1988. Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program, Naval Energy and Environment Support Activity. NEESA 20.2-047B. Port Hueneme, California.
- U.S. Environmental Protection Agency (USEPA), 1987. Data Quality Objectives for Remedial Response Activities Development Process, PB88-131370, EPA/540/G-87/003, Office of Emergency Response and Office of Waste Program Enforcement, Washington, DC, March.
- U.S. Environmental Protection Agency (USEPA), 1989a. Risk Assessment Guidance for Superfund: Volume I-Human Health Evaluation Manual (Part A). Interim Final: Office of Emergency and Remedial Response, EPA/540/1-89/002.
- U.S. Environmental Protection Agency (USEPA), 1989b. RCRA Facility Investigation (RFI) Guidance: Waste Management Division, Office of Soil Waste, USEPA 530/SW-89-031, Washington D.C., May.
- U.S. Environmental Protection Agency (USEPA), 1990a. National Oil and Hazardous Substance Pollution Contingency Plan, Final Rule. 55 Federal Register 866-6. March 8.
- U.S. Environmental Protection Agency (USEPA), 1990b. Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities, Proposed Rule: 55 Federal Register 3078, July 27.

#### REFERENCES (continued)

- U.S. Environmental Protection Agency (USEPA), 1990c. Exposure Factor Handbook. OHEA EPA/600/8-89/043.
- U.S. Environmental Protection Agency (USEPA), 1991a. Contract Laboratory Program - Statement of Work for Organic Analysis. USEPA Document No. OLM01.0.
- U.S. Environmental Protection Agency (USEPA), 1991b. Management of Investigation Derived Waste During Site Inspection. Office of Research and Development. Washington D.C. May.
- U.S. Environmental Protection Agency (USEPA), 1991c. National Functional Guidelines for Organic Data Review. Office of Emergency and Remedial Response. June.
- U.S. Environmental Protection Agency (USEPA), 1991d. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03.
- U.S. Environmental Protection Agency (USEPA), 1991e. Supplemental Region IV Risk Assessment Guidance. Washington D.C. March 26.
- U.S. Environmental Protection Agency (USEPA), 1992a. Guidance for Data Useability in Risk Assessment (Part A). Final. Office of Emergency and Remedial Response, EPA 9285.7-09A, April.
- U.S. Environmental Protection Agency (USEPA), 1992b. Dermal Exposure Assessment: Principles and Applications, Interim Report. Office of Research and Development, Washington, D.C., January.
- U.S. Environmental Protection Agency (USEPA), 1993. Integrated Risk Information System (IRIS). USEPA Database. January.
- Verschueren, Karel, 1983. Handbook of Environmental Data on Organic Chemicals, 2nd Edition, van Nostrand Reinhold.

## 8.0 INTERIM CORRECTIVE MEASURE SCREENING INVESTIGATION ADDENDUM

This section includes the Interim Corrective Measure Screening Investigation Addendum. The addendum discusses the field program, analytical program, and results of activities conducted during January and March 1993. These activities included collection of groundwater samples from 11 PIWs (January) and from locations within and to the north of the landfill.

## REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION unclassified			1b. RESTRICTIVE MARKINGS N/A	
2a. SECURITY CLASSIFICATION AUTHORITY N/A		3. DISTRIBUTION/AVAILABILITY OF REPORT  N/A		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE				
4. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION  ABB Environmental Services, Inc.		6b. OFFICE SYMBOL (if applicable)  ABB-ES		7a. NAME OF MONITORING ORGANIZATION Naval Submarine Base, Georgia
6c. ADDRESS (City, State, and ZIP Code)  1400 Centerpoint Blvd., Suite 158 Knoxville, TN 37932			7b. ADDRESS (City, State, and ZIP Code)  Public Works Department NSB, Code N 561 Kings Bay, Georgia 31547	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION SOUTHNAVFACENGCOM		8b. OFFICE SYMBOL (if applicable) N/A		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER  N62467-89-D-0317
8c. ADDRESS (City, State, and ZIP Code)  2571 Eagle Drive P.O. Box 10068 N. Charleston, SC 29418			10. SOURCE OF FUNDING NUMBERS	
			PROGRAM ELEMENT NO.	PROJECT NO.
11. TITLE (Include Security Classification)  Intermin Corrective Measure Screening Investigation Addendum NSB, Kings Bay, Georgia				
12. PERSONAL AUTHOR(S)  N. Weber, V. Rule				
13a. TYPE OF REPORT Final	13b. TIME COVERED  FROM 1/93 TO 4/93		14. DATE OF REPORT (Year, Month, Day) July 1993	15. PAGE COUNT 125
16. SUPPLEMENTARY NOTATION				
17. COSAT: CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)  VOCs, Site 11, Old Camden County Landfill	
FIELD	GROUP	SUB-GROUP		
19. ABSTRACT (Continue on reverse if necessary and identify by block number)  Follow-on activities to the Interim Corrective Measure Screening Investigation (October and November 1992) included collection of groundwater samples from within and north of Site 11 and from 11 private irrigation wells (PIWs). The limits of VOC contamination within the landfill were identified. Concentrations of VOCs within the landfill are lower than those detected along the west margin and downgradient of the landfill. No plume related VOCs were detected in the samples from PIWs.				
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT  <input type="checkbox"/> Unclassified/Unlimited <input checked="" type="checkbox"/> Same as RPT <input type="checkbox"/> DTIC Users			21. ABSTRACT SECURITY CLASSIFICATION  unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL Mr. Ed Lohr		22b. TELEPHONE (Include Area Code) (803) 743-0577		22c. OFFICE SYMBOL 182

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**CONTRACT TASK ORDER NO. 041  
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CONTRACT NO. N62467-89-D-0317**

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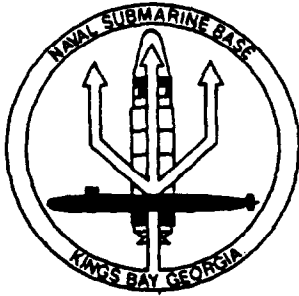
***Prepared for:***

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**July 1993**



## FOREWORD

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), the 1976 Resource Conservation and Recovery Act (RCRA), as augmented by the 1984 Hazardous and Solid Waste Amendments (HSWA), and as directed in Executive Order 12580 of January 1987, the Department of Defense (DOD) conducts an Installation Restoration (IR) Program for evaluating and remediating problems related to releases and disposal of toxic and hazardous materials at DOD facilities.

The Naval Assessment and Control of Installation Pollutants (NACIP) program was developed by the Navy to implement the IR Program for all Naval and Marine Corps facilities. The NACIP program was originally conducted in three phases: (1) Phase I, Initial Assessment Study, (2) Phase II, Confirmation Study (including a Verification Step and a Characterization Step), and (3) Phase III, Planning and Implementation of Remedial Measures. The three-phase IR Program was modified and updated to be congruent with the CERCLA/SARA and RCRA/HSWA-driven DOD IR program.

The updated nomenclature for the RCRA/SARA process is as follows:

- Preliminary Assessment/Site Inspection (PA/SI)
- Remedial Investigation/Feasibility Study (RI/FS)
- Remedial Design/Remedial Action (RD/RA)
- Site Closeout (SC)

Four sites at the Naval Submarine Base (NSB), in Kings Bay, Georgia, were identified for investigation under the IR Program. A work plan for conducting a RCRA Facility Investigation (RFI) at each of the four sites has been completed and implemented. No sampling or analyses will be conducted at the fourth site. The Public Works Department at the NSB will gather information for the fourth site to include in the RFI Report.

Because of the detection of volatile organic compounds in groundwater samples downgradient and off site, an Interim Corrective Measure Screening Investigation (ICMSI) was implemented at Site 11, the Old Camden County Landfill. This addendum presents an evaluation of data collected during a March 1993 field program conducted as part of the initial ICMSI program (reported separately).

Questions regarding this report should be addressed to the NSB Public Affairs office at (912) 673-4714.

## EXECUTIVE SUMMARY

This addendum to the Interim Corrective Measure Screening Investigation (ICMSI) Progress Report was prepared as a result of follow-on activities conducted as part of the ICMSI at Site 11, Old Camden County Landfill, at the Naval Submarine Base in Kings Bay, Georgia. The follow-on activities were conducted in January and March of 1993 and included collection of groundwater samples from private irrigation wells (PIWs) in Crooked River Plantation Subdivision and from locations within and north of the landfill. The following paragraphs summarize the interpretations and evaluations of analytical data obtained from this field effort. The information presented herein does not reiterate, but is in addition to that provided in the ICMSI Progress Report.

Fifty-four groundwater samples, including four duplicate samples, were collected from various depths at 16 locations within and north of the landfill. Samples were analyzed in an on-site laboratory for 10 target volatile organic compounds (VOCs) using gas chromatographic (GC) methods. Target VOCs included vinyl chloride, cis-1,2-dichloroethene, trans-1,2-dichloroethene, trichloroethene, tetrachloroethane, benzene, toluene, ethylbenzene, m-xylene, and o/p-xylene. Six groundwater samples, including one duplicate sample, were submitted to an off-site contract laboratory for analysis of Target Compound List VOCs.

The data obtained during March 1993 indicate that beneath the landfill the plume is similar in composition to the downgradient portion investigated during the initial ICMSI. The same five VOCs were detected in groundwater samples from within the landfill at concentrations above Federal Maximum Contaminant Levels, including vinyl chloride, tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, and benzene. The concentrations of total VOCs beneath most of the landfill area are lower than those detected along and downgradient of the western margin of the landfill, in the direction of groundwater flow. Contaminants were detected in samples from depths ranging from 15 to 85 feet below ground surface (bgs), which is deeper than the 60 feet bgs estimated for off-site contamination.

The occurrence of VOCs in the 11 PIW samples collected during January 1993 was sporadic. Two of the PIWs sampled were at locations known to overlie the plume. Acetone was detected in one of the two PIW samples and no other VOCs were detected. VOCs detected in one or more of the remaining PIW samples, from locations outside the plume, include VOCs that are commonly observed artifacts of laboratory or sampling procedures (acetone and 2-butanone); trihalomethanes that are commonly formed in water chlorinated for drinking supply (bromoform, bromodichloromethane, and dibromochloromethane); and solvents (trichloroethene, toluene, and styrene).

#### ACKNOWLEDGEMENTS

In preparing this addendum, the personnel at ABB Environmental Services, Inc. commend the support, assistance, and cooperation provided by the personnel at NSB Kings Bay, Georgia, and SOUTHNAVFACENGCOM. In particular, we acknowledge the outstanding effort, dedication, and professionalism provided by the following people in the preparation of this report.

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## LIST OF ACRONYMS

bgs	below ground surface
CLP	USEPA Contract Laboratory Program
GC	gas chromatographic
GPR	ground penetrating radar
ICMSI	Interim Corrective Measure Screening Investigation
MCL	Maximum Contamination Limit
MDL	Minimum Detection Limit
ml	milliliter
$\mu\text{g}/\ell$	micrograms per liter
MS	matrix spike
MSD	matrix spike duplicate
NEESA	Naval Energy and Environment Support Activity
NSB	Naval Submarine Base
%R	percent recovery
PARCC	precision, accuracy, representativeness, completeness, and comparability
PIW	private irrigation well
QC	quality control
RFI	RCRA Facility Investigation
RPD	relative percentage difference
SOW	Statement of Work
TCL	Target Compound List
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds

## 1.0 INTRODUCTION

Under contract to the U.S. Department of the Navy (Navy) Southern Division, Naval Facilities Engineering Command, this addendum to the Interim Corrective Measure Screening Investigation (ICMSI) Progress Report was prepared for Site 11, the Old Camden County Landfill, located on the Naval Submarine Base (NSB) in Kings Bay, Georgia. This report was prepared under the Navy's Comprehensive Long-term Environmental Action, Navy Contract No. N62467-89-D-0317, Contract Task Order No. 041. This report concludes the activities required for the ICMSI.

The ICMSI was initiated as part of the overall Resource Conservation and Recovery Act Facility Investigation (RFI) field program at NSB Kings Bay to establish whether the volatile organic compounds (VOCs) detected in groundwater downgradient of Site 11 have migrated into the Crooked River Plantation Subdivision. The ICMSI was planned to establish whether an immediate threat to human health exists within the subdivision. The ICMSI Progress Report (Progress Report) documents the findings of the original investigation, including a human health screening risk evaluation. The Progress Report also provides a detailed site description and regulatory information that are not repeated here.

1.1 OBJECTIVES OF THE INTERIM CORRECTIVE MEASURE SCREENING INVESTIGATION ADDENDUM. This addendum documents the findings related to groundwater samples collected from locations within and north of the landfill and from private irrigation wells (PIWs) located within the Crooked River Plantation Subdivision. This sampling was conducted in January and March of 1993. The objectives of collecting these additional samples were to provide sufficient information to evaluate the following:

- the horizontal and vertical extent of groundwater VOC contamination within the landfill boundaries,
- VOC contaminants of potential concern, if any, in the PIW water samples collected within the Crooked River Plantation Subdivision.

The information presented in this addendum does not reiterate, but is in addition to that provided in the ICMSI Progress Report.

1.2 REPORT ORGANIZATION. This addendum presents an interpretation and evaluation of data collected during the January and March 1993 sampling event as part of the ICMSI conducted at the Old Camden County Landfill and includes the following:

- Introduction includes the objectives for the additional activities of the investigation and report organization;
- Site Investigation Program discusses the site-specific field program and activities;
- Quality Assurance Program and Data Quality Assessment discusses the analytical program, and data quality and use;
- Results of the Investigation discusses the chemical and hydrogeologic data in relation to interpreting the site's physical conditions;

- Summary and Recommendations summarizes the results of the additional ICMSI site activities in support of recommendations for a Corrective Measures Study.

## 2.0 SITE INVESTIGATION PROGRAM

The following subsections describe the scope and components of the follow-on investigation to the ICMSI field program at the Old Camden County Landfill. Included are discussions of methods used to select hydropunch locations through use of ground-penetrating radar (GPR) and to collect samples of groundwater using hydropunch equipment and from PIWs.

2.1 SAMPLE IDENTIFICATION. During March 1993 activities, sample location identifiers for samples collected from landfill locations were consecutive beginning with location 147. Locations 101 through 146 were used during the initial ICMSI activities.

Sample identification for groundwater samples collected using the hydropunch includes location and depth information as described below:

G      147    25  
G = hydropunch  
147 = location identifier  
25 = upper limit of a 1-foot sample interval in feet below ground surface (bgs)

PIW samples collected in January 1993 were labeled consecutively starting with location 52, preceded by CRP-PW, which signifies a PIW in the Crooked River Plantation Subdivision. Locations 1 through 51 were used during the initial ICMSI activities. The sample labels are cross-referenced with location codes identifying the PIW's corresponding street name and number on Table 2-1.

The location codes are needed for the geographical information system database to manage data from multiple sample events at a single location.

The analytical program for the investigation included on-site laboratory analyses of all groundwater samples collected from the landfill using the hydropunch for 10 target VOCs:

vinyl chloride  
cis-1,2-dichloroethene  
trans-1,2-dichloroethene  
trichloroethene  
tetrachloroethene  
benzene  
toluene  
m/p-xylene  
o-xylene  
ethylbenzene

The hydropunch samples were analyzed in an on-site laboratory with a minimum of 10 percent of the samples submitted to an off-site contract laboratory for analysis of VOCs using U.S. Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) methods. All the PIW samples were submitted to the contract laboratory for analysis.

Table 2-1 PIW Location Codes and Corresponding Sample Identification

Sample Identification	PIW Location Code <sup>1</sup>
PW52	204COCO
PW53	114CACI
PW54	213PLCO
PW55 <sup>2</sup>	204PLCO
PW56	106CHPDR
PW57 <sup>3</sup>	310FADR
PW58	301CHPDR
PW59	314SUDR
PW60	300FADRR
PW61	309WODR
PW62	206SUDR

<sup>1</sup> Location codes include numeric prefix and alphabetical suffix. Numeric prefix is the house number in the address. The alphabetical suffix is an abbreviation of the street name. An example follows:

Location Code	Address
FADR	Fairfield Lane
CHPDR	Cherry Point Drive
WODR	Woodlawn Drive
SUDR	Sunnyside Drive
PLCO	Plantation Court
COCO	Cottage Court
CACI	Cambray Circle

<sup>2</sup> Same location as PW7, sampled during the initial ICMSI field program.

<sup>3</sup> Same location as PW36, sampled during the initial ICMSI field program.

**2.2 SUBSURFACE EXPLORATION.** Previous investigations revealed the presence of trenches of waste materials within the Site 11 landfill. These trenches range from approximately 575 to 775 feet in length and 35 to 50 feet in width. Depth of the trenches is reportedly 8 to 12 feet bgs. Spacing between the trenches ranges between 3 and 5 feet. Based on results of the GPR survey conducted in March 1993, discussed in the following paragraphs, the depth to refuse ranges from 2 to 3 feet bgs. The areas between the trenches are interpreted to represent areas of the landfill that do not have substantial amounts of refuse beneath them.

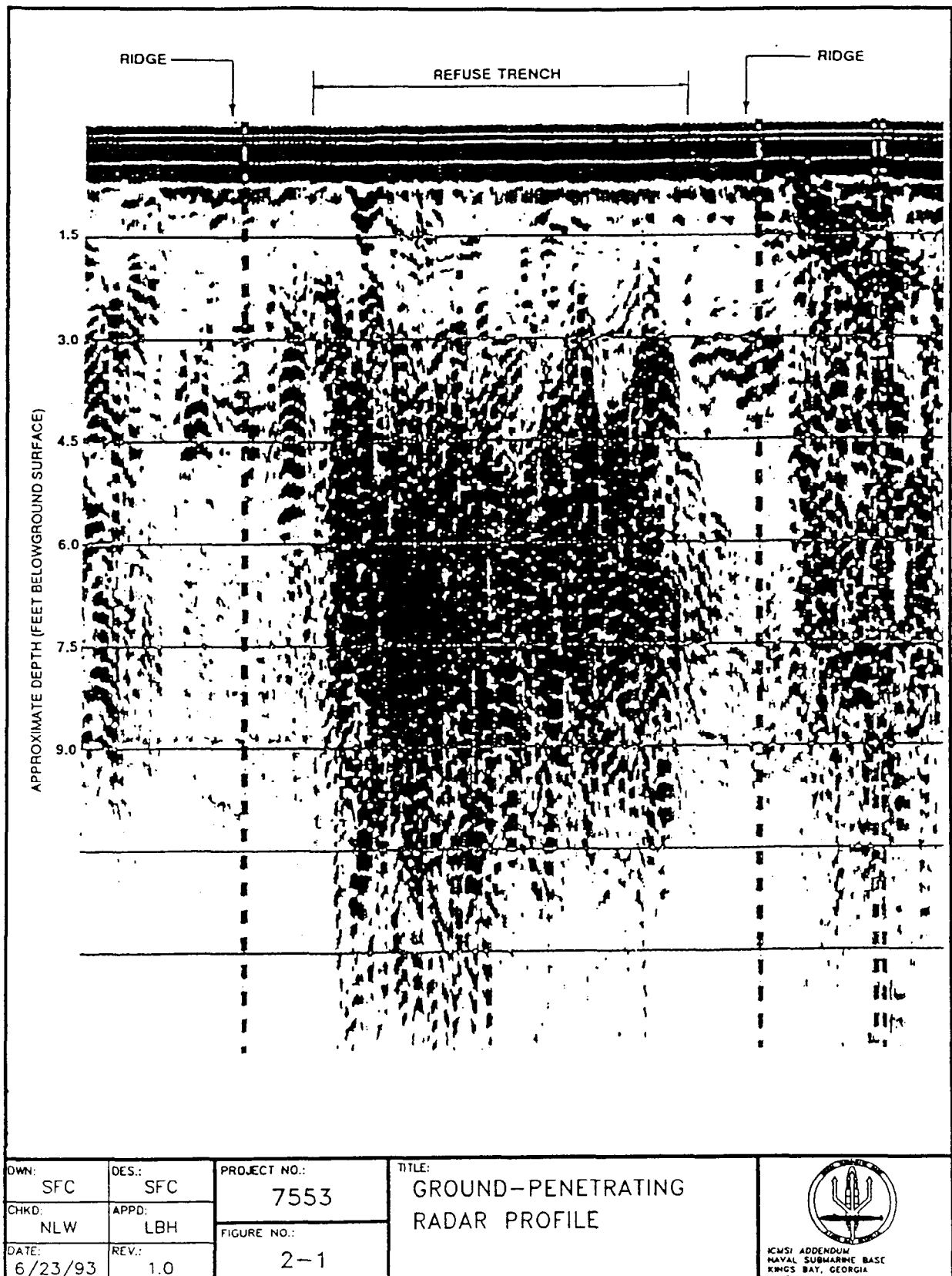
A GPR survey was conducted at Site 11 to assist in the selection of hydropunch locations within the landfill that would not encounter substantial amounts of refuse. The GPR technique uses high frequency radio waves to establish the presence of subsurface objects and structures.

Thirty-two proposed hydropunch locations were staked within the landfill boundary, based on the results of GPR data. Proposed locations were surveyed using GPR to verify they were clear of substantial amounts of refuse. The GPR survey was conducted with a GSSI System III GPR unit equipped with a 500-megahertz antenna.

Figure 2-1 shows the reflection signature of a portion of the GPR profiles conducted at the landfill. The GPR signature of the trenches compared to areas that did not receive waste is evident, as shown in Figure 2-1. Trenches are characterized by chaotic reflections and diffractions. Trenches most likely display this signature because of the nature of landfilled materials and the fact that refuse tends to retain moisture in the unsaturated zone. Areas not appearing to have received waste are typified by reflection-free signatures with some diffractions. These radar signatures are indicative of thickly bedded sands. These types of sedimentary deposits were observed during the cone-penetrometer survey conducted in October and November of 1992.

**2.3 HYDROPUNCH GROUNDWATER SAMPLING.** The hydropunch groundwater sampling device consists of a stainless steel telescoping assembly containing an airtight and watertight sealed intake screen and sample chamber that is isolated from the surrounding environment. The tool attaches to a standard drill rod and is advanced through the hollow-stem augers by driving the drill rod with a 140-pound hammer. The hydropunch sampler is advanced a distance of 5 feet beyond the augers. When the desired depth for collection is reached, the hydropunch is opened by pulling back on the drill rod. Soil friction holds the drive cone in place as the body of the hydropunch moves back. Once the O-ring seal between the drive cone and the body of the tool is broken, groundwater flows from the surrounding formation into the sample chamber. As the sample is collected, the drive cone and sample chamber are tightly sealed against the borehole walls. This "packer" effect isolates the intake from groundwater above and below and results in a discrete 11-inch sample interval.

Once open, the hydropunch sample chamber fills from the bottom with no aeration and minimal agitation of the sample. As the tool is pulled upward, increased hydrostatic head within the tool closes lower and upper check valves that retain the sample within the body of the hydropunch. Once at the surface, the hydropunch is inverted and the sample is decanted through a top discharge valve and tubing.



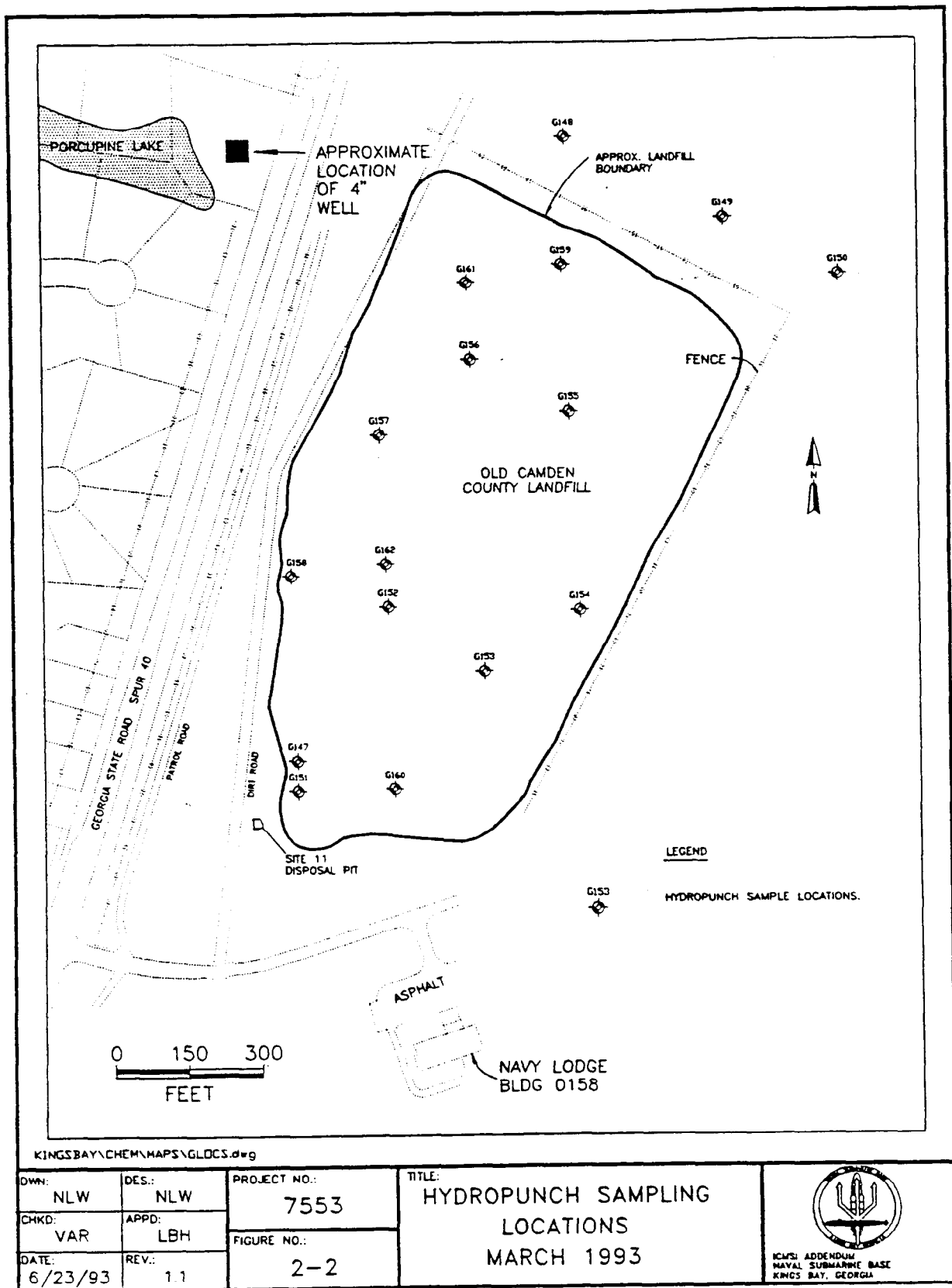
To collect water samples from multiple intervals, the existing borehole is advanced by hollow-stem auger drilling and a clean hydropunch sampler is advanced for sample collection.

During a 9-day period from March 15 to March 24, 1993, groundwater samples were collected from 16 locations within and to the north of the landfill. Figure 2-2 shows the locations where the hydropunch samples were collected. Sample depths ranged from 12 to 90 feet bgs. Sample locations and depth intervals were chosen based on analytical information provided by the on-site laboratory. Thus, the location and depth interval of successive samples were selected based on analytical information from preceding samples. Sampling objectives included evaluating the horizontal and vertical extent of VOC contamination and characterizing concentrations of VOCs in the plume.

Fifty-four groundwater samples, including four duplicate samples, were collected for analysis of target VOCs in the on-site laboratory. Six groundwater samples, including one duplicate sample, were submitted for off-site analysis at the contract laboratory. A sample from G152 (G15230) and a duplicate from this location were submitted for off-site analysis. This sample was not analyzed onsite. Off-site analysis included Target Compound List (TCL) VOCs using the USEPA CLP Statement of Work (SOW) for multi-media samples (USEPA, 1991a). Section 3.0 provides more detailed information about the analytical program for this investigation. The results of this sampling effort are discussed in Section 4.0.

On March 24, 1993, a monitoring well was installed at hydropunch location G162 (see Figure 2-2). The monitoring well was installed following completion of hydropunch sampling, which extended to a depth of 18 feet bgs. The boring was extended to 20 feet bgs and the monitoring well constructed inside the hollow-stem augers. Well construction inside hollow-stem augers involves gradually removing the augers from the borehole as the filter pack and bentonite seal are placed. Figure 2-3 is a construction diagram and boring log for the new monitoring well (KBA-11-10). Well construction materials included Schedule 40, flush threaded polyvinyl chloride well screen and riser pipe. The well screen is 10 feet long and has 0.01-inch machined slots. The filter pack is made up of 20-30 mesh silica sand and extends 2 feet above the top of the screen. A 1-foot-thick bentonite pellet seal was placed on top of the filter pack. The remainder of the annulus was grouted using Type I Portland cement. Well development consisted of pumping 270 gallons of water from the well. Approximately 100 gallons of potable water was used during placement of the sand pack to manage problems associated with bridging of sand within the augers. Groundwater was initial brown and silty but cleared during development. No samples have been collected from this new monitoring well.

**2.4 PRIVATE IRRIGATION WELL SAMPLING.** On two occasions, residents of the Crooked River Plantation Subdivision were provided questionnaires requesting information about PIWs. Ninety-four PIWs were identified. The second questionnaire requested permission to collect groundwater samples from PIWs and asked property owners for physical information about their PIWs and specifics of use. The initial ICMSI field program included sampling of 51 PIWs. Nine additional PIWs were sampled on January 12 and 13, 1993. Two previously sampled PIWs were also resampled. Figure 2-4 shows the locations of the PIWs sampled in January 1993. All samples were analyzed for TCL VOCs in the off-site contract laboratory using the USEPA CLP SOW for multimedia samples (USEPA, 1991a). Copies




TITLE: NSB KINGS BAY				LOG of WELL: KBA-11-10		BORING NO.	
CLIENT: U.S. NAVY, SOUTHNAVFACENGCON						PROJECT NO: 7553-33	
CONTRACTOR: Ground Water Protection				DATE STARTED: 3/24/93		COMPLTD: 3/24/93	
METHOD: HSA		CASE SIZE: 2"		BORING DIA: 8.25"		PROTECTION LEVEL: 0	
TOC ELEV.: FT.		MONITOR INST.: PORTA FID		TOT DPTH: 20FT.		DPTH TO $\nabla$ FT.	
LOGGED BY: L. W. Smith		WELL DEVELOPMENT DATE: 3/24/93				SITE: II	

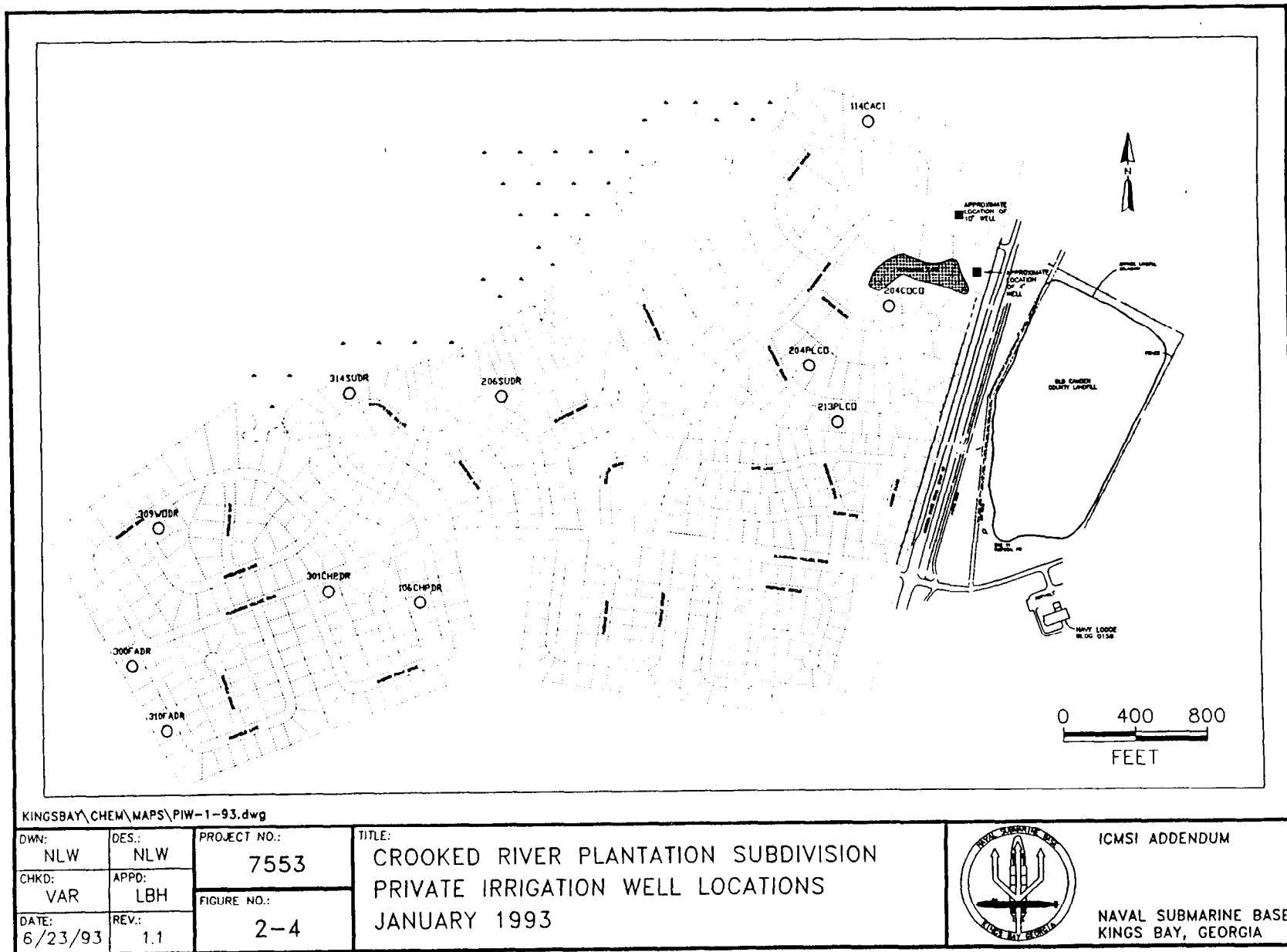
  

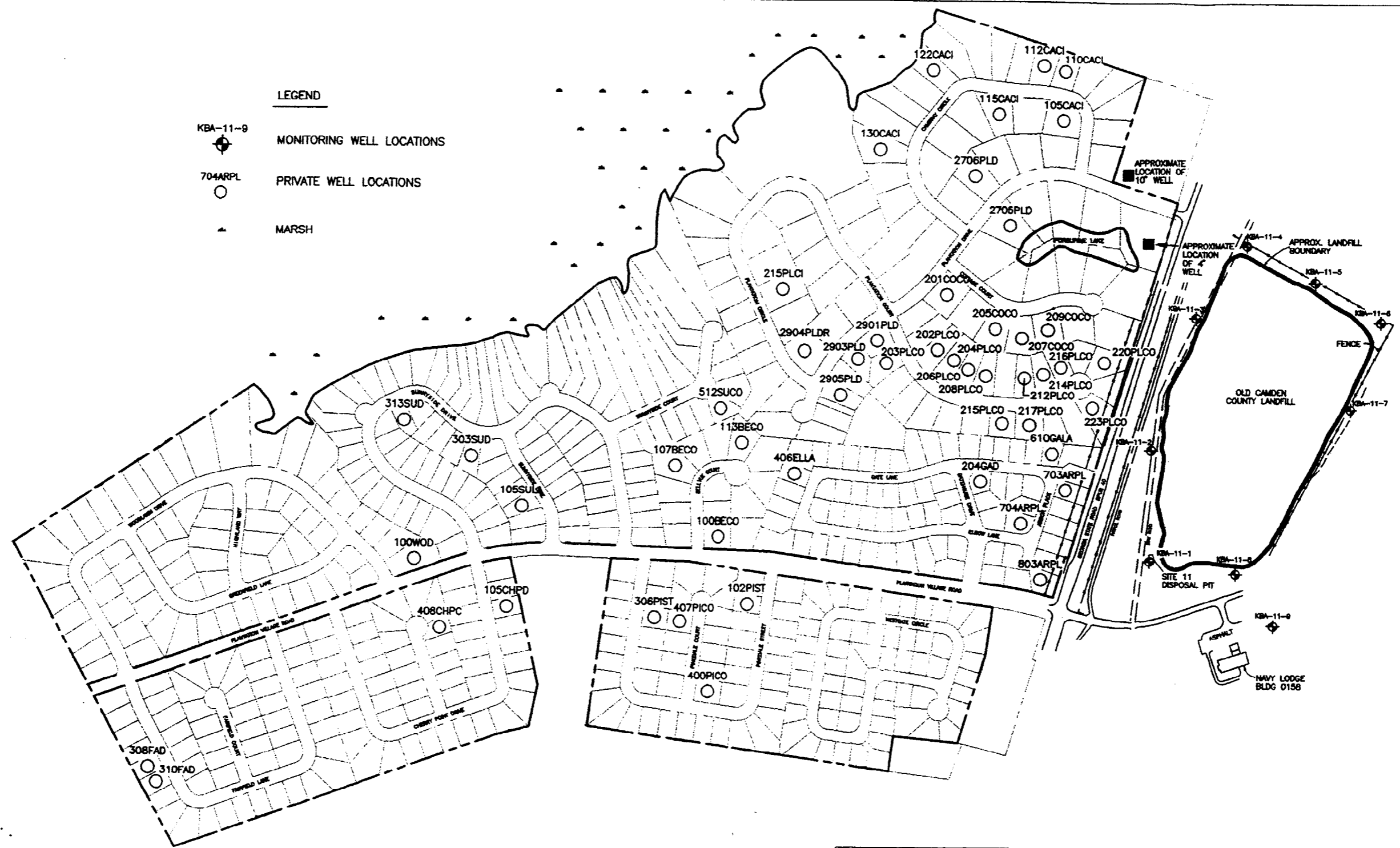
DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Topsail, light grey to light tan		SC		
					Silty sand, dark brown, medium to fine				
5									
10									
15									
20					boring terminated at 20 ft.				
25					NOTE: log estimated from cuttings				

PAGE 1 of KB-11-10

OWN: TLK	DES.: TLK	PROJECT NO.: 7553	BORING LOG AND WELL CONSTRUCTION DIAGRAM FOR KBA-11-10	 ICMS ADDENDUM NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: LBH	APPD: LBH	FIGURE NO.: 2-3		
DATE: 6/24/93	REV.: 1.0			





DWN:	DES:	PROJECT NO.:	TITLE:
DMF	LGT	7553	PRIVATE IRRIGATION WELL LOCATIONS
CHKD:	APPD.:	FIGURE NO.:	
LBH	LBH	2-4	
DATE:	REV.:		
8-3-93			



INTERIM CORRECTIVE MEASURE SCREENING  
INVESTIGATION REPORT  
MARINE SUBMARINE BASE, KINGS BAY, GEORGIA

05104037

of completed questionnaires and consent forms for the additional PIWs sampled are provided in Appendix A.

Samples were placed in 40 milliliter (ml) vials directly from spigots or sprinkler heads. When samples were collected from sprinkler heads, the heads were removed so that samples could be collected from a steady flow with minimum aeration. Before sample collection, each well was purged for 15 minutes, during which time flow rates were measured by measuring the time required to fill a 5-gallon bucket. Flow rates were not measured for PIWs that were purged and sampled through sprinkler heads. Flow rate data for the PIWs are provided in Table 2-2. The chemical results of this sampling effort are discussed in Section 4.0 of this report.

2.5 DECONTAMINATION PROCEDURES. Hydropunch sampling equipment that came in contact with sample material was cleaned as follows:

1. Steam-cleaned with potable water.
2. Washed with Alconox<sup>TM</sup> and distilled water.
3. Rinsed with distilled water.
4. Rinsed with pesticide-grade isopropanol.
5. Rinsed with deionized, organic-free water.
6. Air dried.
7. Wrapped in aluminum foil.

Isopropanol used in decontamination was collected in a plastic bucket and allowed to evaporate. Periodically, unused portions of groundwater samples from on-site analyses were returned to the site. The groundwater and decontamination fluids, other than isopropanol, were disposed of within the area of contamination (within the landfill boundaries) in accordance with USEPA guidance for management of investigation-derived waste (USEPA, 1991b).

Table 2-2 PIW Flow Rates

Sample Identification	Flow Rate (gpm)
PW52	NA
PW53	7.3
PW54	6.4
PW55	5.5
PW56	5.5
PW57	5.0
PW58	12.0
PW59	7.5
PW60	NA
PW61	4.8
PW62	7.5

NA Flow rates out of sprinkler heads were not measured  
gpm = gallons per minute

### 3.0 QUALITY ASSURANCE PROGRAM AND DATA QUALITY ASSESSMENT

This section summarizes the analytical program for on-site and off-site analyses of groundwater samples and PIW samples collected during the 1993 follow-on ICMSI field activities at Site 11. In addition, it assesses on-site and off-site data quality and useability and compares on-site and off-site analytical results.

**3.1 ANALYTICAL PROGRAM.** Field activities during the screening investigation included the collection of groundwater samples from the landfill using hydropunch equipment and from PIWs. All samples were collected in accordance with procedures outlined in the Quality Assurance Project Plan, Appendix A, of the NSB Kings Bay RFI/Site Investigation Work Plan (ABB-ES, 1991). Groundwater samples from the landfill were analyzed in an on-site laboratory with a minimum of 10 percent of the samples submitted for confirmatory off-site analysis. PIW groundwater samples were submitted to the off-site laboratory and were not analyzed in the on-site laboratory. Table 3-1 summarizes the sampling and analysis program for samples collected for on-site and off-site laboratory analysis.

**3.1.1 On-Site Chemical Analysis** Hydropunch groundwater samples collected for on-site analysis were analyzed for target VOCs using a gas chromatographic (GC) field laboratory. The analytical method was a modification of the USEPA 8010/8020 purge-and-trap GC method as described in the ICMSI Work Plan (ABB-ES, 1992).

**3.1.1.1 On-Site Analytical Method** Modifications to the USEPA 8010/8020 Method are summarized in this subsection. Samples were analyzed using an LSC-2000 purge-and trap unit connected to a Hewlett-Packard™ 5890 GC. A DB-624 75-meter megabore column was used for compound separation. The on-site GC was equipped with a purge-and-trap unit and two detectors, a photometric ionization detector and an electrolytic conductivity (Hall) detector. A standard sample volume of 25 milliliters was used for each analysis. The following run conditions were established:

- LSC-2000 purge time = 6 minutes
- LSC-2000 desorb time = 3 minutes
- LSC-2000 bake time = 5 minutes
- HP 5890 injection port temperature = 225 °C
- HP 5890 detector port temperature = 275 °C
- HP 5890 initial oven temperature = 35 °C
- HP 5890 oven temperature ramp = 6 °C per minute
- helium carrier flow = 10 ml per minute
- helium make-up flow = 20 ml per minute
- hydrogen make-up flow = 75 ml per minute

**3.1.1.2 Performance Criteria** The quality control (QC) criteria for the on-site analytical method were established to monitor method performance. An initial three-point calibration for quantitation (low, mid-range, and high concentrations) was performed for each instrument. Target compounds and reporting limits are presented on Table 3-2. Instrument stabilities were monitored every 24 hours with a calibration standard at the mid-range concentration. The quantitation performance criterion for operation was agreement of the check standard with the three-point calibration curve to within 30 percent.

Table 3-1 Summary of Sampling and Analysis Program for Samples Collected for On-site and Off-site Analysis

Type of Sampling	Number of VOC Analyses	
	On-site	Off-site
Groundwater	50	5
Private Irrigation Wells	0	11
Field Duplicates		
Groundwater	4	1
Private Irrigation Wells	0	3
Quality Control Samples		
Trip Blanks	0	4
Equipment Rinsate Blanks	9	3
Source Water Blanks	2	2
MS/MSDs	3	2
Method Blanks	10	8

Notes:

VOC = Volatile Organic Compound

MS/MSD = Matrix Spike/Matrix Spike Duplicate

Table 3-2 Target Compounds and Reporting Limits for On-site Analysis

Compound Name	Reporting Limit (µg/l)
Vinyl Chloride	1.0
trans-1,2-Dichloroethene	1.0
cis-1,2-Dichloroethene	1.0
Trichloroethene	1.0
Tetrachloroethene	1.0
Benzene	1.0
Toluene	1.0
Ethylbenzene	1.0
m/p-Xylene	2.0
o-Xylene	1.0

Note: µg/l = micrograms per liter

The identities of the target compounds were based on comparison with the retention times for the standards. Retention time windows of plus or minus 3 percent were established, based on the most recent calibration curve. Every 24 hours, a method blank of deionized water was analyzed to confirm that no target compounds were introduced by sample handling and analysis. The method blank criterion was met if no target compounds were present above the reporting limit for the instrument. A surrogate solution containing 100 micrograms per liter ( $\mu\text{g/l}$ ) of bromofluorobromine was injected into each sample to establish percentage recoveries. The recovery range of 30 to 170 percent was established as one of the operating criteria for on-site analyses.

**3.1.2 Off-Site Analysis** In accordance with the ICMSI Work Plan (ABB-ES, 1992), a minimum of 10 percent of all groundwater samples collected for on-site VOC analysis and all PIW samples were submitted to a contract laboratory for chemical analysis. Table 3-1 summarizes the sampling and analysis program for samples collected for off-site analysis. Samples for VOC analysis were analyzed according to the USEPA CLP SOW for multi-media samples (USEPA, 1991a). Naval Energy and Environmental Support Activity (NEESA) Level D documentation (NEESA, 1988) was used for VOC analyses. Appendix B contains validated Level D Data.

Because many target VOCs currently have Federal Primary Drinking Water Maximum Contaminant Levels (MCLs) below their respective CLP Contract Required Quantitation Limits, it was necessary to achieve lower reporting limits for VOCs. Based on VOC Method Detection Limit (MDL) studies performed and submitted by the contract laboratory, lower reporting limits for VOCs were achieved. Table 3-3 lists the TCL VOCs, their corresponding MDLs, and the reporting limits used during this investigation. All reporting limits listed in Table 3-3 are lower than corresponding Federal Primary Drinking Water MCLs. Appendix B contains data supporting the MDL study.

**3.2 DATA QUALITY ASSESSMENT.** Data generated by the on-site and off-site laboratories were reviewed against applicable performance criteria. In addition, data quality indicators of precision, accuracy, representativeness, comparability, and completeness (PARCC) were evaluated and established for both on-site and off-site data, as discussed below.

**3.2.1 On-Site Data Quality and Use** All samples collected for on-site analysis during the screening investigation were properly preserved, placed in coolers, and packed with ice immediately after collection. All samples remained in the custody of an investigation team member until delivery to the on-site laboratory. Except for one groundwater sample (G15230), all groundwater samples collected during the investigation were analyzed by the on-site laboratory. Groundwater sample G15230 could not be analyzed on site because of insufficient sample volume; however, this sample was analyzed by the off-site laboratory.

**3.2.1.1 Analytical Performance** Review of analytical data indicated the on-site laboratory generally met applicable analytical QC criteria for VOC analyses. All tuning criteria, extraction and analysis holding times, initial and continuing calibration standard criteria, and internal standard/surrogate recoveries were met. Overall, no qualification of environmental data was required based on precision and accuracy criteria. However, qualifications were required because several analytical method blanks contained target compounds at concentrations ranging from below the reporting limit of 1.0  $\mu\text{g/l}$  to 2.7  $\mu\text{g/l}$ . Table 3-4 summarizes compounds detected in on-site analytical method blanks. In accordance

Table 3-3 Method Detection Limits (MDLs) and Reporting Limits for Volatile Organic Compounds

	MDL (µg/l)	Reporting Limit (µg/l)
<b>Volatile Organic Compounds (37 total)</b>		
<b>Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration, USEPA Document No. OLM01.0, 1991.</b>		
Chloromethane	0.203	1
cis-1,3-Dichloropropene	0.274	1
Bromomethane	0.396	1
Trichloroethene	0.185	1
Vinyl Chloride	0.165	1
Dibromochloromethane	0.190	1
Chloroethane	0.147	1
1,1,2-Trichloroethane	0.268	1
Methylene Chloride	9.712	10
Benzene	0.235	1
Acetone	3.491	5
trans-1,3-Dichloropropene	0.097	1
Carbon Disulfide	0.114	1
Bromoform	0.230	1
1,1-Dichloroethene	0.175	1
2-Hexanone	0.465	5
1,1-Dichloroethane	0.205	1
4-Methyl-2-Pentanone	0.746	5
cis-1,2-Dichloroethene	0.215	1
Tetrachloroethene	0.340	1
trans-1,2-Dichloroethene	0.254	1
1,1,2,2-Tetrachloroethane	0.391	1
Chloroform	0.285	1
Toluene	0.167	1
1,2-Dichloroethane	0.160	1
Chlorobenzene	0.238	1
2-Butanone	0.709	5
Ethylbenzene	0.195	1
1,1,1-Trichloroethane	0.221	1
Styrene	0.240	1
Carbon Tetrachloride	0.354	1
Xylenes (total)	0.141	1
Bromodichloromethane	0.144	1
1,3-Dichlorobenzene	0.126	1
1,2-Dichloropropane	0.236	1
1,4-Dichlorobenzene	0.164	1
1,2-Dichlorobenzene	0.222	1

Note: µg/l = micrograms per liter

Table 3-4 Summary of Compounds Detected in On-site Analytical Method Blanks

Compound	Reporting Limit	Blank ID Numbers (µg/l)				
		GC002	GC011	GC020	GC032	GC053
Vinyl chloride	1	1 U	1 U	1 U	1 U	0.41 J
trans-1,2-Dichloroethene	1	1 U	1 U	0.98 J	1.0	1 U
cis-1,2-Dichloroethene	1	0.74 J	0.63 J	0.93 J	0.97 J	0.65 J
Trichloroethene	1	2.7	1 U	1 U	1 U	1 U
Tetrachloroethene	1	0.28 J	0.63 J	0.82 J	0.89 J	0.74 J
Benzene	1	0.66 J	1 U	0.71 J	0.77 J	1 U
Toluene	1	0.29 J	1.4	0.50 J	0.52 J	0.34 J
Ethylbenzene	1	0.30 J	1.8	0.72 J	0.71 J	0.62 J
m/p-Xylene	2	0.35 J	2 U	2 U	2 U	2 U
o-Xylene	1	0.60 J	1 U	0.34 J	0.35 J	1 U

Compound	Reporting Limit	Blank ID Numbers (µg/l)				
		GC059	GC069	GC088	GC108	GC122
Vinyl chloride	1	1 U	1 U	1 U	0.79 J	1 U
trans-1,2-Dichloroethene	1	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1	0.62 J	0.79 J	0.56 J	1.1	0.47 J
Trichloroethene	1	1 U	1 U	1 U	1.1	1 U
Tetrachloroethene	1	0.76 J	0.59 J	0.54 J	1.0	0.48 J
Benzene	1	0.57 J	0.57 J	0.57 J	0.68 J	1 U
Toluene	1	1.6	1.1	0.78 J	0.85 J	0.43 J
Ethylbenzene	1	0.83 J	0.82 J	0.84 J	1.2	0.62 J
m/p-Xylene	2	2 U	2 U	2 U	2 U	2 U
o-Xylene	1	0.74 J	0.47 J	0.50 J	0.63 J	1 U

Notes: U = compound not detected at the stated quantitation limit  
 J = sample result is considered estimated because it is less than the reporting limit  
 µg/l = micrograms per liter

with NEESA Level C guidelines (NEESA, 1988), all positive sample results associated with method blank contamination were qualified as undetected if the sample concentration was less than five times the blank concentration. Sample concentrations greater than five times associated method blank concentrations did not require qualification.

**3.2.1.2 On-Site Data Use** Performance criteria for the on-site analytical method, described in Subsection 3.1.1.2, were used to assess the quality of data generated by the field laboratory. PARCC parameters were established based on the extent of conformance to these performance criteria.

The accuracy and precision of the on-site analytical method were established. Accuracy was calculated based on the range of matrix spike percentage recoveries (%R) for matrix spike/matrix spike duplicate (MS/MSD) samples and precision was calculated based on the relative percentage difference (RPD) between spike results for MS/MSD samples. Calculation of %R and RPD are as follows:

$$\%R = (\text{spike sample result} / \text{concentration of spike added}) \times 100 \quad (1)$$

and

$$RPD = \frac{|\text{MS result} - \text{MSD result}|}{(\text{MS result} + \text{MSD result}) / 2} \times 100 \quad (2)$$

Three sets of MS/MSD samples were analyzed on site during field activities and the precision and accuracy results for the target compounds are shown in Table 3-5. The accuracy range was 73 to 210 and the precision range was 0 to 18 percent. Overall, no qualification of environmental data was required based on accuracy criteria.

Representativeness is a qualitative parameter that expresses how well the sampling represents the environmental conditions of the sampled media. Field duplicate samples, equipment rinsate samples, and source water blanks were collected to give an indication of representativeness and to monitor method reproducibility. A total of four duplicate samples were collected and analyzed on site. Analytical results for duplicate samples are presented in Table 4-1 in Section 4.0 of this document. In general, results for field duplicates show good agreement with RPD values ranging from 0 to 35 percent. Nine equipment rinsate samples and two source water blanks were collected and analyzed by the on-site laboratory. None of the rinsate samples or source water blanks contained target compounds.

The completeness of the on-site data set was measured by establishing what percentage of the data set was considered valid after data review. Valid results are defined as those results from analyses meeting the performance criteria defined by calibration checks and surrogate recoveries. The completeness for all analytes was established to be 100 percent.

Comparability is discussed in Subsection 3.2.3 of this document.

Overall, data generated by the on-site analytical laboratory met USEPA Level II criteria for field screening and are suitable for use in site characterization, engineering design, and evaluation of remedial alternatives.

Table 3-5 Summary of Precision and Accuracy for On-site MS/MSD Analysis

Compound	MS/MSD Recovery Range (Accuracy)	RPD Range (Precision)
Vinyl Chloride	76-100	3-9
trans-1,2-Dichloroethene	110-210	0-2
cis-1,2-Dichloroethene	120-180	0-13
Trichloroethene	89-150	9-14
Tetrachloroethene	100-170	7-14
Benzene	90-120	2-10
Toluene	73-110	9-16
Ethylbenzene	92-120	0-8
m/p-Xylene	90-120	9-10
o-Xylene	91-120	0-18
USEPA Method 8010/8020	75-120	2-28

Notes:

RPD = Relative Percentage Difference

MS/MSD = Matrix Spike/Matrix Spike Duplicate

**3.2.2 Off-Site Data Quality and Use** All samples collected for off-site analysis were properly preserved, placed in coolers, and packed with ice immediately after collection. All samples remained in the custody of an investigation team member until delivery to the courier service providing overnight shipment to the laboratory. All samples requiring off-site analysis were shipped, complete with chain-of-custody forms, to the contract laboratory within 24 hours for analysis. Upon arrival at the laboratory, the chain-of-custody and preservation of the samples were checked with the contents of each cooler. After verification, the chain-of-custody form was signed and the samples accepted for analysis.

Review of the field notebook and chain-of-custody forms did not indicate any non-conformance relative to field instrument calibration or sample handling. Except for one sample delivery, all required field QC samples were collected in conformance with the requirements of the USEPA, NEESA, and ABB-ES Quality Assurance Plans and the June 1988 NEESA "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program" (NEESA, 1988) (Document 20.2-047B). These field QC samples included field duplicates, equipment rinsate blanks, source water blanks, and VOC trip blanks for each VOC sample shipment.

Analytical results for environmental samples collected during the investigation were evaluated and validated according to NEESA Level D QC criteria to establish data quality and useability. NEESA Level D documentation and validation requirements are equivalent to USEPA Level IV requirements. The data tables included in Appendix B reflect validation according to Level D criteria, which are described in Subsection 7.3.1 of NEESA Document 20.2-047B. The following subsections discuss analytical performance and the evaluation of field and laboratory QC samples.

**3.2.2.1 Analytical Performance** Data review and NEESA Level D validation were performed under subcontract. Review of analytical data indicated the laboratory generally met applicable analytical QC criteria for all chemical analyses. Appendix C of this report contains a detailed evaluation of each PARCC parameter and data tables summarizing analytical results for MS/MSD samples, initial and continuing calibration standards, field duplicate samples, and compounds detected in method blanks, trip blanks, rinsate blanks, and source water blanks (Appendix C). The following subsections summarize evaluations of each PARCC parameter.

For VOC analyses, all analytical holding times, tuning criteria, internal standard/surrogate recoveries, and MS/MSD criteria were met. Except for one equipment rinsate sample, BS126ER, no qualifications were required based on precision or accuracy criteria. The positive sample result for acetone in BS126ER was qualified as estimated and flagged with a J qualifier because an associated continuing calibration standard exceeded QC limits for acetone.

Field duplicate samples, analytical method blanks, trip blanks, equipment rinsate samples, and source water blanks were collected to give an indication of representativeness and to monitor method reproducibility. A total of four duplicate samples were collected and analyzed off site. Analytical results for duplicate samples are presented in Tables 4-2 and 4-3 in Section 4.0 of this document. In general, results for field duplicates show good agreement. However, one set of PIW replicate samples, PW-55/PW-55D, showed disagreement in results for one common laboratory contaminant, acetone (see Table 4-3 in Section 4.0). Acetone was detected in replicate samples PW-55 and PW-55D at 19 and 32

µg/l, respectively; however, the result for PW-55D was qualified as undetected due to method blank contamination. The poor replication of acetone in duplicate samples and the prevalence of acetone in several method blanks associated with this investigation and previous investigations at Site 11 indicate that the concentrations of acetone detected in PIW samples are most likely laboratory artifacts.

Four trip blanks, three equipment rinsate blanks, and two source water blanks were submitted for off-site VOC analysis. The equipment rinsate samples were collected during decontamination procedures involving hydropunch equipment. The source water blanks represented organic-free, deionized water used as a final rinse during equipment decontamination procedures (BS113FB) and potable water used to steam-clean hydropunch equipment (BS114FB). Trip blanks accompanied each VOC sample shipment to monitor contamination introduced during sample collection, shipment, and storage. However, one sample shipment including PIW samples PW-60, PW-61, PW-61D, PW-62, and PW-55D did not contain a trip blank. One common laboratory contaminant, 2-butanone, was detected in one sample associated with the shipment (PW-61D) but was not detected in the replicate sample (PW-61). The presence of 2-butanone in PW-61D is considered suspect and may be due to laboratory or sampling contamination.

Appendix B provides tables summarizing compounds detected in analytical method blanks, trip blanks, rinsate blanks, and source water blanks and an evaluation of the impact of contamination on data useability. In summary, the representativeness of the data was only affected by the prevalence of acetone, methylene chloride, and carbon disulfide in analytical method blanks and the prevalence of acetone in rinsate samples. The occurrence of acetone, methylene chloride, and carbon disulfide in method blanks and field blanks render data for these compounds suspect for groundwater and PIW samples containing these compounds at concentrations that could not be directly attributed to contamination.

Comparability could not be accurately measured for data collected during this investigation because environmental samples were not submitted to two different contract laboratories; however, the results of the on-site analyses were compared to those of the off-site results and are discussed in Subsection 3.2.3 of this document.

The completeness goal for laboratory analysis for this investigation was 95 percent useable data. Unusable data are those results reported by the laboratory but rejected during the validation process. For all samples collected during this investigation, the analytical completeness was established to be 100 percent.

**3.2.2.2 Off-Site Data Use** Overall, the data generated during this investigation meet Level D data quality objectives established for the ICMSI and are acceptable for use in site characterization and evaluation. Blank qualifications for VOCs resulted in elevated detection limits for the chemicals discussed earlier. The widespread occurrence of acetone, and methylene chloride and the unknown origin of carbon disulfide in method blanks and field blanks render data for these compounds suspect for groundwater and PIW samples containing these compounds at concentrations that could not be directly attributed to contamination. The source of these contaminants will be further investigated during future field programs at NSB Kings Bay.

### 3.2.3 Comparison of On-Site Laboratory Results and Off-Site Laboratory Results

Four groundwater samples that were analyzed on site were also analyzed by the off-site laboratory. A summary of analytical results for the 10 target VOCs analyzed by both laboratories, in units of  $\mu\text{g/l}$ , are as follows:

<u>Sample</u>	<u>Compound</u>	<u>On-site</u>	<u>Off-site</u>
G15030	(no target VOCs detected by either analysis)		
G15885	vinyl chloride	1.5	1 U
	cis-1,2-dichloroethene	7.0	1 U
	toluene	4.0	2
G15940/G15940D	vinyl chloride	4.6/4.3	1 U
	cis-1,2-dichloroethene	18/20	6
	ethylbenzene	16/22	15
	m/p-xylene	2 U/2 U	12 (total)
	o-xylene	4.6/1 U	12 (total)
G16035	vinyl chloride	6.9	1 U
	cis-1,2-dichloroethene	64 J	22
	trichloroethene	1 U	3
	benzene	12	5
	toluene	20	11
	ethyl benzene	8.4	6
	m/p-xylene	6.4	14 (total)
	o-xylene	8.6	14 (total)

Except for vinyl chloride and cis-1,2-dichloroethene, on-site laboratory results correlated well with off-site results when target compounds were detected in both on-site and off-site samples at concentrations greater than five times the quantitation limit. Comparison of vinyl chloride and cis-1,2-dichloroethene results for on-site and off-site samples indicated that the off-site laboratory may have experienced a loss of sensitivity for these compounds. The loss of sensitivity most likely occurred during shipment to the laboratory via air transport or during sample preparation at the analytical laboratory.

Based on the comparison of the on-site and off-site results, the on-site data can be used to augment the off-site data for site characterization.

#### 4.0 RESULTS OF INVESTIGATIONS

4.1 ON-SITE GROUNDWATER CONTAMINATION. Analytical data from on-site analyses are presented in Table 4-1. Table 4-2 summarizes validated analytical data for the off-site analysis of groundwater samples collected using the hydropunch. Hydropunch sample locations are shown in Figure 2-2.

Figures 4-1 through 4-3 show the approximate horizontal extent of VOC contamination at various depth intervals. Figure 4-4 shows locations of cross-sections D-D' (Figure 4-5), E-E' (Figure 4-6), and F-F' (Figure 4-7). The interpreted plan views (Figures 4-1 through 4-3) and the cross-sections (Figures 4-5 through 4-7) are based on on-site laboratory GC data associated with the Phase I Interim Investigation, the initial ICMSI data, and the additional data provided in this addendum. The initial ICMSI provided data on off-site target VOC concentrations. This additional investigation provided information about the concentration of target VOCs beneath the landfill. Therefore, the western extent of the plume that was defined in the initial ICMSI Progress Report did not change as a result of this investigation.

The isoconcentration contours portrayed in Figures 4-1 through 4-3 and 4-5 through 4-7 are computer generated using GIS/KEY™ in combination with QUICKSURF™. The area representing the plume is approximated from data associated with actual sample locations. The actual presence of plume constituents at locations within the contoured areas and between sample locations can only be verified by actual sampling and analysis of groundwater at those locations.

Data collected during the March 1993 hydropunch groundwater sampling indicate that vinyl chloride and dichloroethene are the primary halogenated VOCs present, which is consistent with data from off-site locations collected during the initial ICMSI field program. The same five VOCs detected above Federal MCLs in the initial ICMSI were also the only five target VOCs to be detected above MCLs during this additional sampling effort. The five VOCs are vinyl chloride, trichloroethene, cis-1,2-dichloroethene, tetrachloroethene, and benzene. MCLs are included on analytical data tables for on-site and off-site analyses. Of these five VOCs, vinyl chloride concentrations were above its MCL of 2 µg/l more frequently than any other target VOC, just as was found in the initial ICMSI. Vinyl chloride was detected at concentrations above its MCL at 11 of 15 locations sampled, and in 27 out of 49 samples. Vinyl chloride was present at 85 feet bgs at location G158, and at 15 feet bgs at G158, G153, and G152.

The data indicate that the concentrations of target VOCs detected in samples collected from within the landfill are generally less than concentrations detected from locations along and downgradient of the western margin of the landfill (Figures 4-1 through 4-3 and 4-5 through 4-7). With the exception of data associated with sample G158 (50 feet bgs), concentrations of total target VOCs detected during March 1993 on-site analyses ranged from 1 µg/l at location G161 (17 feet bgs) on the north side of the landfill to 188 µg/l at location G158 (70 feet bgs) on the west side of the landfill (see Figure 2-2 and Table 4-1). One sample from location G158 (50 feet bgs) contained 1,537 µg/l total target VOCs. A sample from G152 (30 feet bgs) at the center of the landfill that was analyzed off site for TCL VOCs contained 2,153 µg/l total VOCs, 931 µg/l attributed to the 10 target VOCs analyzed in the on-site laboratory.

Table 4-1 On-site Analytical Data for Hydropunch Groundwater Samples

Compound	MCL	Sample ID Numbers (µg/l)									
		G14730	G14745	G14830	G14845	G14845D	G14930	G14945	G15030	G15045	G15125
Vinyl chloride	2	31	1.4 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-dichloroethene	100	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-dichloroethene	70	8.2	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	5	1.3 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1,000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	700	15	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
m/p-Xylene	10,000	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
o-Xylene	10,000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Compound	MCL	Sample ID Numbers (µg/l)									
		G15145	G15215	G15245	G15260	G15275	G15290	G15290D	G15315	G15330	G15350
Vinyl chloride	2	1 U	56 J	14	4.7	2.6	10	11	2.0	1 U	10
trans-1,2-Dichloroethene	100	1 U	1 U	1.3 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	70	1 U	3.0 U	24	2.9 U	3.7 U	11	12	3.8 U	11	9.5
Trichloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	5	1 U	2.7 U	6.4	1 U	1 U	1 U	1.2 U	2.1 U	3.0 U	5.9
Toluene	1,000	1 U	1.3 U	38 J	27	6.0	23	24	1 U	1 U	5.6
Ethylbenzene	700	1 U	26	17	1.2 U	1.1 U	3.1	3.2	1 U	2.7	1 U
m/p-Xylene	10,000	2 U	19	18	2 U	2 U	2.8	3.0	2 U	2 U	2 U
o-Xylene	10,000	1 U	11	5	1 U	1 U	2.1	2.2	1 U	1 U	1 U

See notes at end of table.

Table 4-1 (continued) On-site Analytical Data for Hydropunch Groundwater Samples

Compound	Sample ID Numbers (µg/l)										
	MCL	G15365	G15383	G15425	G15440	G15460	G15535	G15565	G15625	G15625D	G15645
Vinyl chloride	2	1 U	1.1	6.9	14	1.9	5.7	1 U	10.0	8.3	27
trans-1,2-dichloroethene	100	1 U	1 U	1.8 U	1.4 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-dichloroethene	70	2.1 U	1.4 U	35 J	76 J	63 J	23	2.0 U	40 J	28	100
Trichloroethene	5	1 U	1 U	1 U	5.9	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	1 U	1.8 U	1 U	5.1	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	5	1 U	1 U	2.8 U	7.4	2.3 U	6.2	1 U	28	24	16
Toluene	1,000	1 U	1.1 U	1 U	13	16	1.1 U	1 U	1 U	1 U	1.5 U
Ethylbenzene	700	1 U	1 U	7.9	18	7.0	20	1.6 U	9.9	7.6	33
m/p-Xylene	<sup>1</sup> 10,000	2 U	2 U	2 U	7.0	2.1	2 U	2 U	2 U	2 U	7.6
o-Xylene	<sup>1</sup> 10,000	1 U	1 U	1 U	8.2	2.8 U	1 U	1 U	1.4 U	1 U	2.8

Compound	Sample ID Numbers (µg/l)										
	MCL	G15660	G15720	G15735	G15755	G15770	G15815	G15830	G15850	G15870	G15885
Vinyl chloride	2	1.9	8.2	15	7.8	1 U	1.5	1.8	30	14	1.5
trans-1,2-Dichloroethene	100	1 U	1 U	1 U	1 U	1 U	1 U	1 U	12	1 U	1 U
cis-1,2-Dichloroethene	70	4.6	1 U	2.1	2.6	1 U	1.4	1.3	1100 J	140	7.0
Trichloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	2.0 U	1 U	1 U	1 U	1 U	1 U	1 U	24	1 U	1 U
Benzene	5	1.6 U	2.3 U	4.0	1.4 U	1 U	1.1 U	1.3 U	12	2.1	1.2 U
Toluene	1,000	1 U	1.2 U	2.9 U	1.9 U	1 U	1 U	1 U	150 J	34	4.0
Ethylbenzene	700	6.8	2.8	56 J	5.3	1 U	1 U	2.8	61	1 U	1.6 U
m/p-Xylene	<sup>1</sup> 10,000	4.7	2 U	8.4	2 U	2 U	2 U	2 U	73	2 U	2 U
o-Xylene	<sup>1</sup> 10,000	2.1	1 U	4.5	1.1 U	1 U	3.2	1 U	75	1 U	1.6 U

See notes at end of table.

Table 4-1 (continued) On-site Analytical Data for Hydropunch Groundwater Samples

Compound	MCL	Sample ID Numbers (µg/l)									
		G15915	G15940	G15940D	G15955	G16016	G16035	G16050	G16117	G16135	G16145
Vinyl chloride	2	1 U	4.6	4.3	1 U	1.1 U	6.9	1 U	1 U	13	1 U
trans-1,2-dichloroethene	100	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-dichloroethene	70	3.1 U	18	20	1 U	2.1 U	64 J	1 U	1 U	89 J	32 J
Trichloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	5	1 U	1 U	3.4	1 U	1 U	12	1 U	1.0	7.1	9.0
Toluene	1,000	1 U	1 U	1 U	1 U	1 U	20	1 U	1 U	1 U	28
Ethylbenzene	700	1 U	16	22	1 U	6.5	8.4	1 U	1 U	1 U	2.9
m/p-Xylene	<sup>1</sup> 10,000	2 U	2 U	2 U	2 U	2 U	6.4	2 U	2 U	10	2 U
o-Xylene	<sup>1</sup> 10,000	1 U	4.6	1 U	1 U	1 U	8.6	1 U	1 U	1 U	2.4

Compound	MCL	Sample ID Numbers (µg/l)			
		G16155	G16165	KBA-11-10 (12')	KBA-11-12 (18')
Vinyl chloride	2	1 U	1 U	1.4	1 U
trans-1,2-Dichloroethene	100	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	70	1.2 U	1 U	1 U	8.1
Trichloroethene	5	1 U	1 U	1 U	1 U
Tetrachloroethene	5	1 U	1 U	1 U	1 U
Benzene	5	1 U	1 U	1.3	1 U
Toluene	1,000	1.4 U	1 U	1 U	1 U
Ethylbenzene	700	1 U	1 U	1 U	1 U
m/p-Xylene	<sup>1</sup> 10,000	2 U	2 U	2 U	2 U
o-Xylene	<sup>1</sup> 10,000	1 U	1 U	1 U	1 U

Notes: <sup>1</sup> = total xylenes

J = sample result is considered estimated because concentration exceeded the linear range of the instrument

U = compounds not detected at the stated quantitation limit

MCL = Maximum Contaminant Level, USEPA Office of Water, December 1992; The Bureau of National Affairs, Inc., July 1992.

Table 4-2 Summary of Off-site Laboratory Analysis of Hydropunch Samples

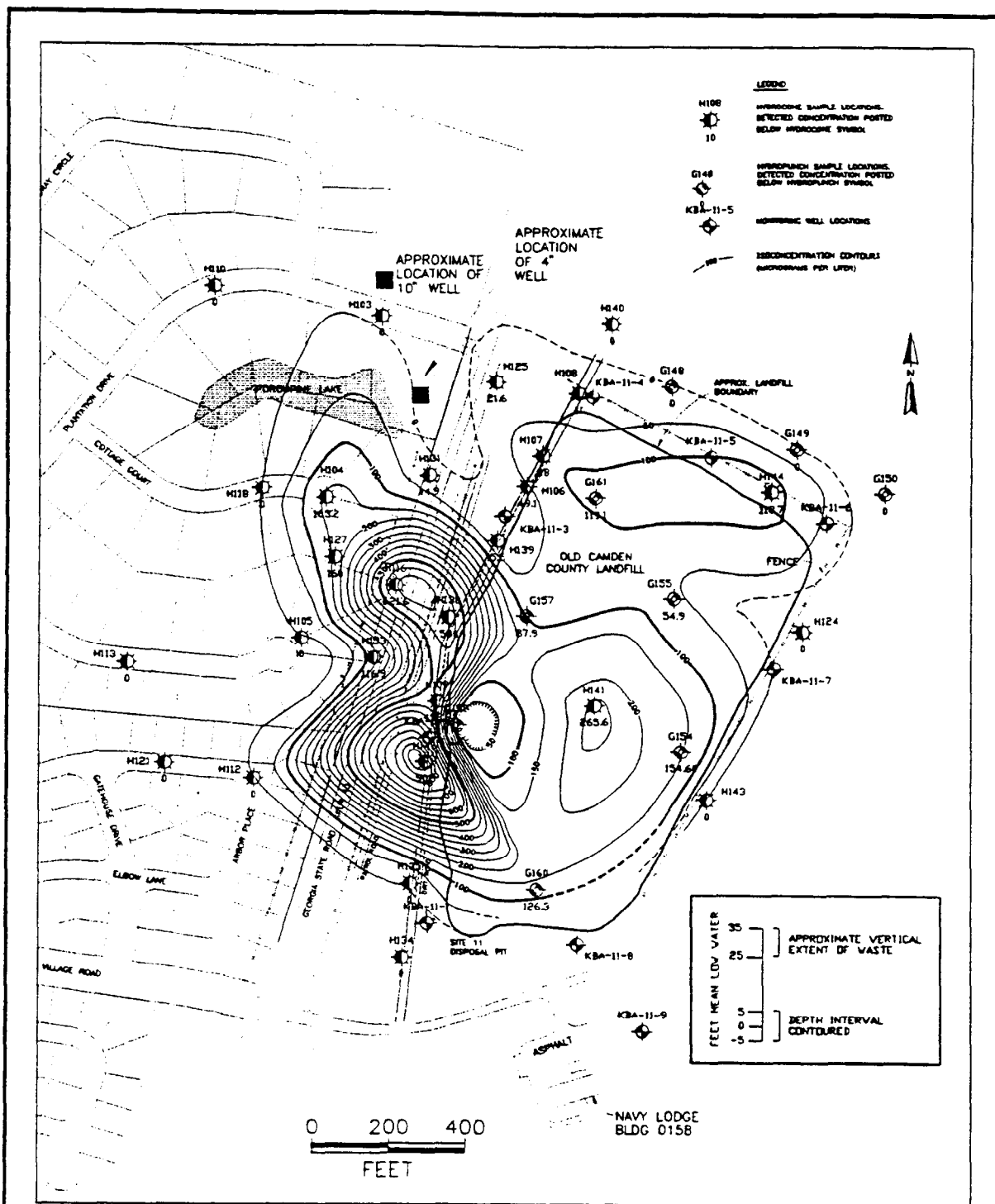
Compound	Hydropunch Sampling Locations (µg/l)						
	MCL	G15030	G15230	G15230D	G15885	G15940	G16035
Methylene chloride	NA	2 U	37	41	2 U	2 U	3
Acetone	NA	5 U	280	310	800	5 U	24 U
2-Butanone	NA	5 U	440	480	5 U	5 U	5 U
2-Hexanone	NA	5 U	19	17	5 U	5 U	5 U
4-Methyl-2-pentanone	NA	5 U	100	110	5 U	5 U	5 U
Carbon disulfide	NA	3	200	250	1 U	1 U	3
Chloroform	100	1 U	1 U	1 U	3	1 U	1 U
1,1-Dichloroethane	NA	1 U	12	14	1 U	1 U	17
Trichloroethene	5	1 U	3	3	1 U	1 U	3
cis-1,2-dichloroethene	70	1 U	2	2	1 U	6	22
Benzene	5	1 U	1	1	1 U	1 U	5
Toluene	1,000	1 U	720	840	2	1 U	11
1,4-Dichlorobenzene	75	1 U	1 U	1 U	1 U	3	1 U
Ethyl benzene	70	1 U	16	18	1 U	15	6
Xylenes (total)	10,000	1 U	62	67	1 U	12	14


Notes: U = compound was not detected at the stated concentration

NA = none applicable

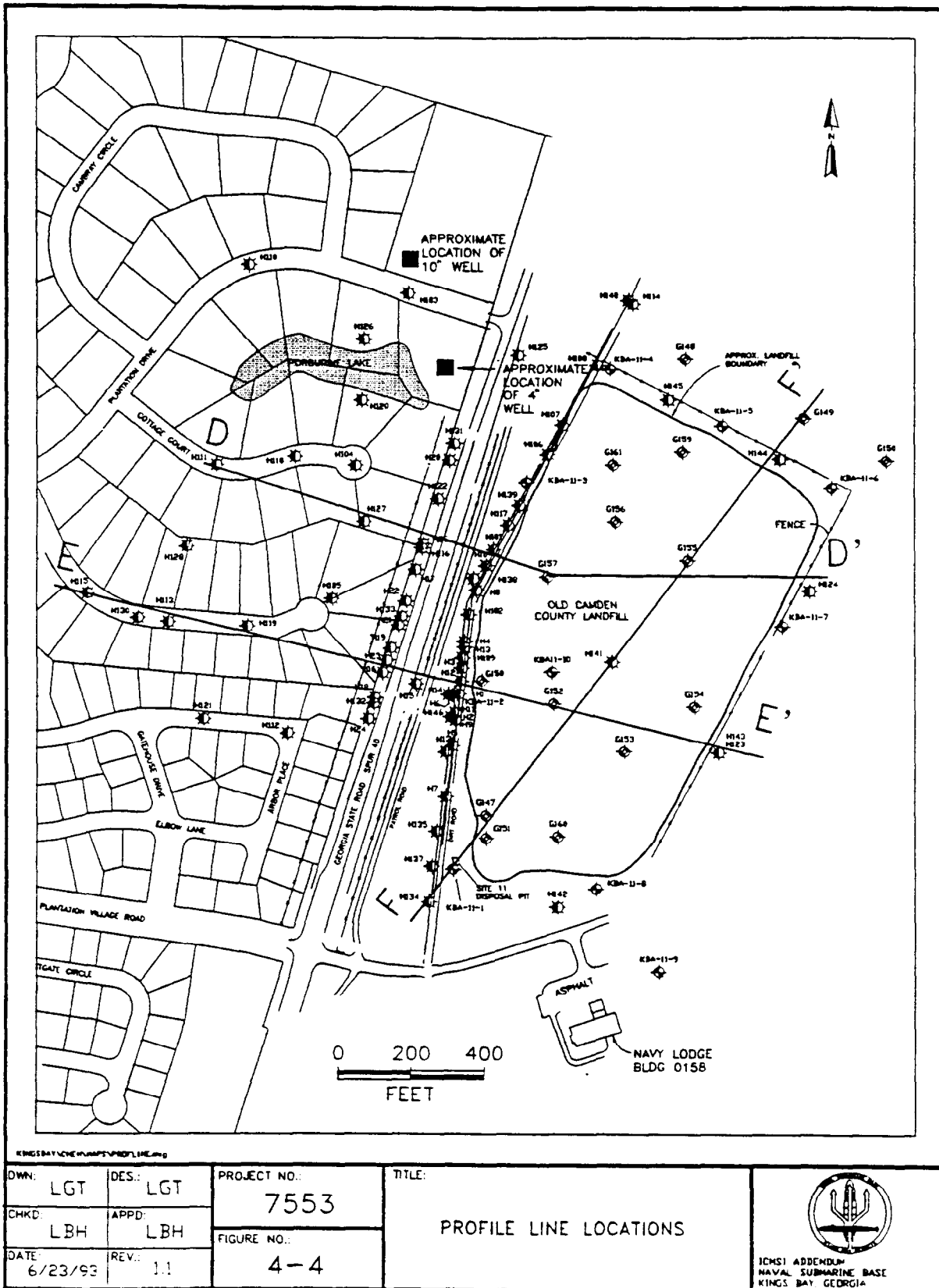
MCL = Maximum Contaminant Level, USEPA Office of Water, December 1992; The Bureau of National Affairs, Inc., July 1992.

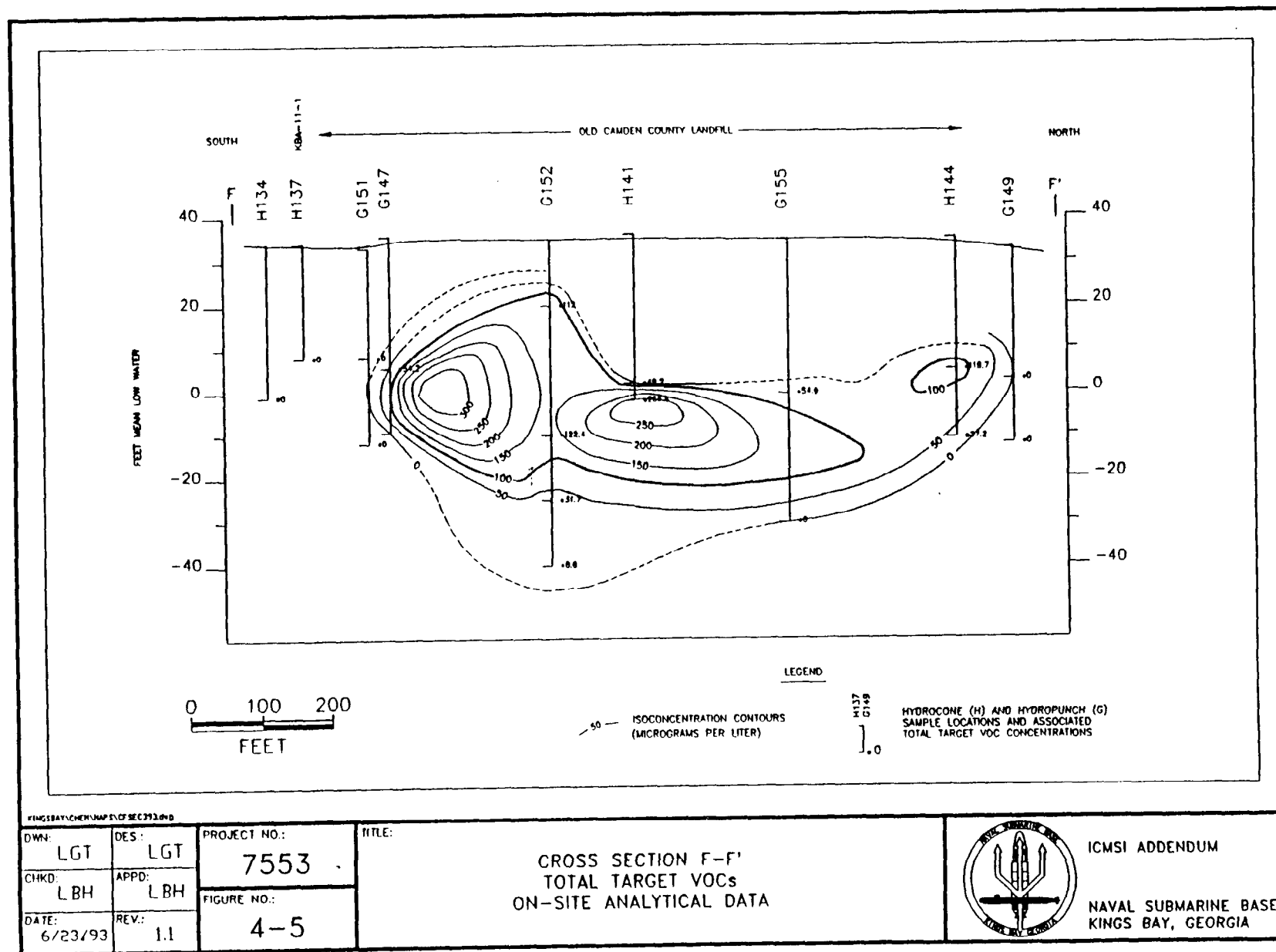




DWN LGT		DES. LGT	PROJECT NO. 7553	TITLE	 ICMS ADDENDUM NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD LBH		APPD. LBH	FIGURE NO. 4-2	INTERPRETED PLUME PLAN VIEW 5 TO -5 FT MEAN LOW WATER TOTAL TARGET VOCs	
DATE 6/23/93		REV. 1.1			







KINGS BAY, GEORGIA, 1993

DWN:	LGT	DES:	LGT
CHKD:	LBH	APPD:	LBH
DATE:	6/23/93	REV:	1.1

PROJECT NO.:	7553
FIGURE NO.:	4-5

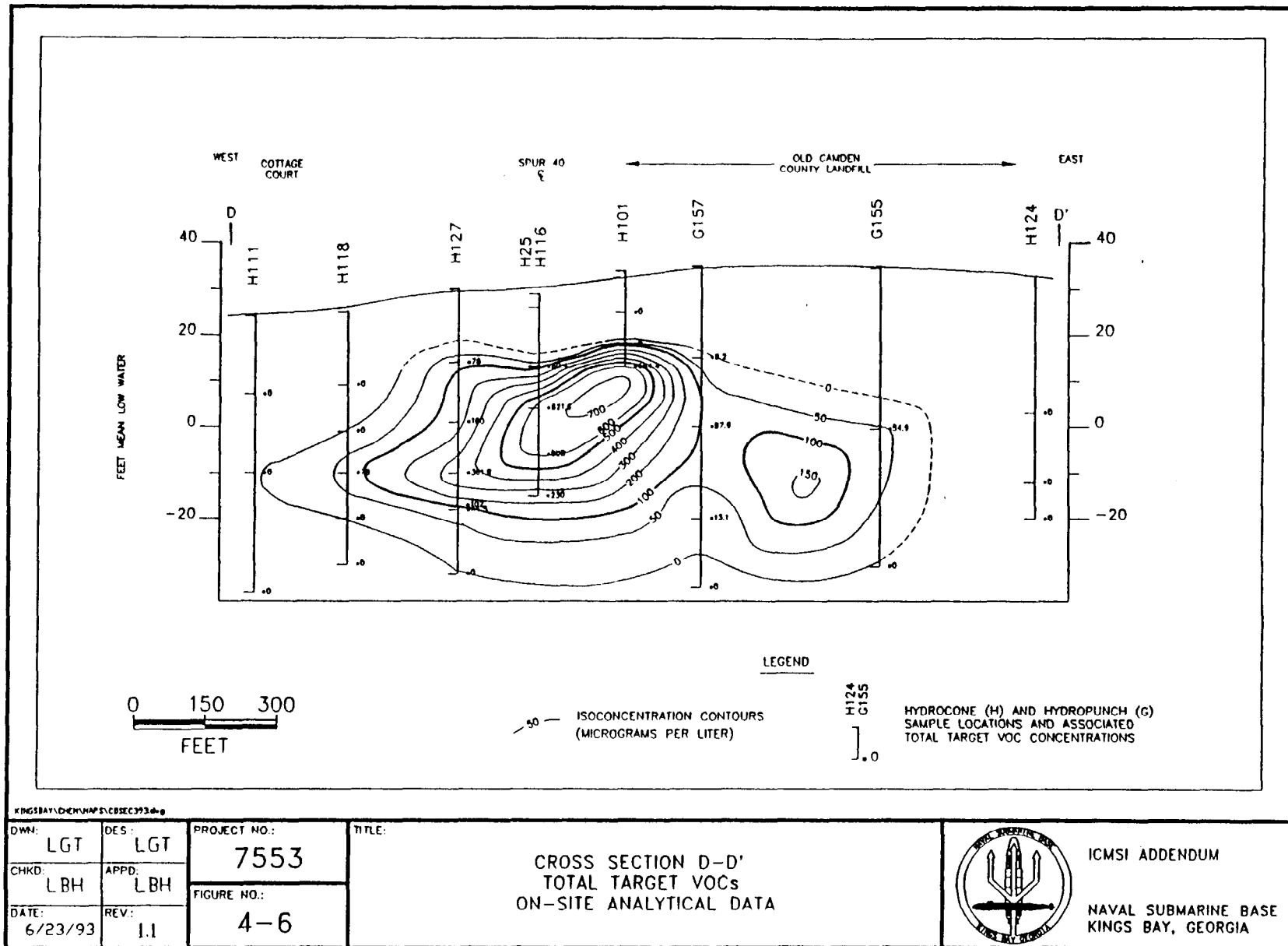
TITLE:

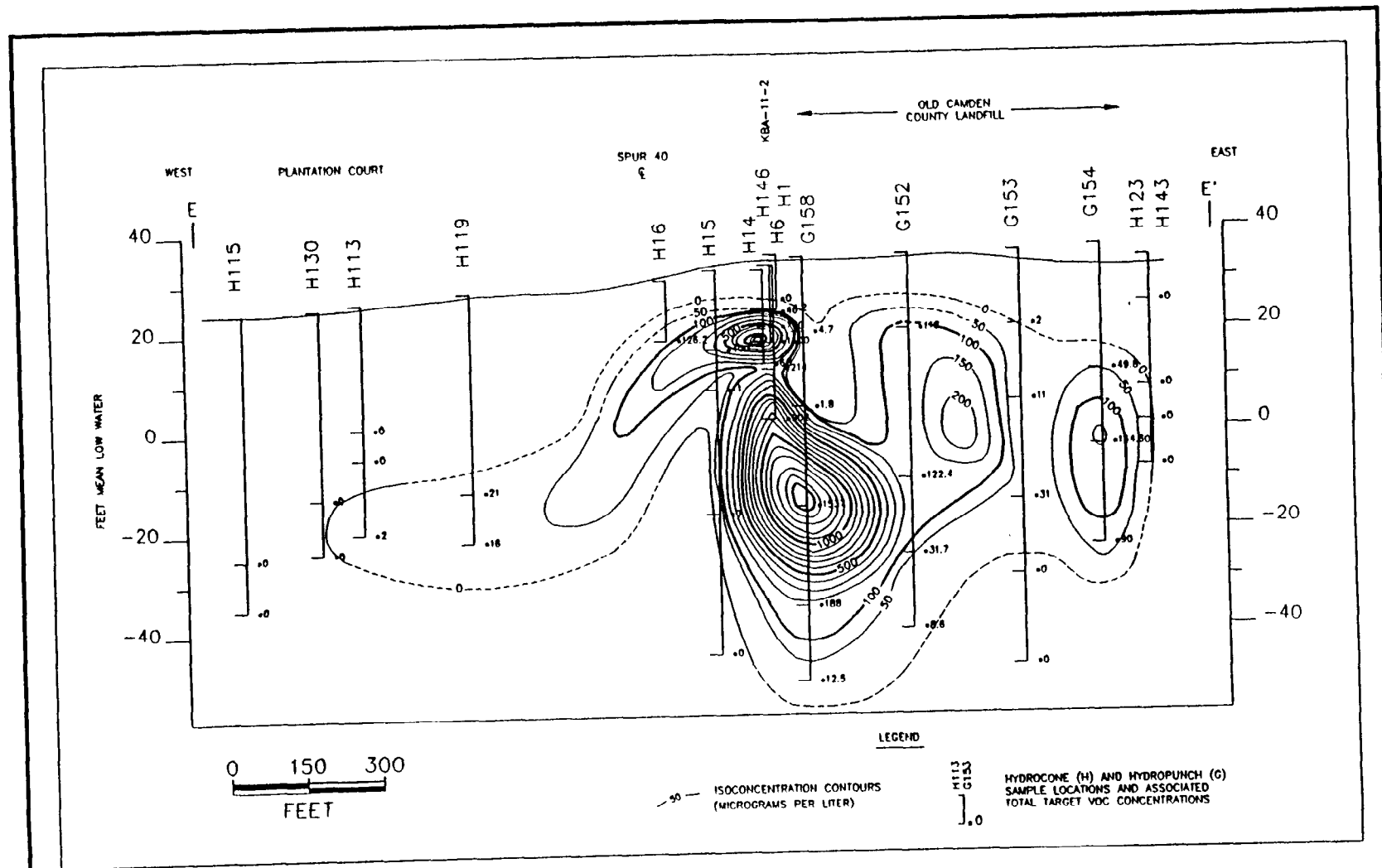
**CROSS SECTION F-F'**  
**TOTAL TARGET VOCs**  
**ON-SITE ANALYTICAL DATA**



ICMSI ADDENDUM

**NAVAL SUBMARINE BASE  
KINGS BAY, GEORGIA**





KINGS BAY CHEM MAPS \CSE\3797.dwg

DWN:	LGT	DES:	LGT
CHKD:	LBH	APPD:	LBH
DATE:	6/23/93	REV:	1.1

PROJECT NO:	7553
FIGURE NO.:	4-7

TITLE:

CROSS SECTION E-E'  
TOTAL TARGET VOCs  
ON-SITE ANALYTICAL DATA



ICMSI ADDENDUM

NAVAL SUBMARINE BASE  
KINGS BAY, GEORGIA

One sample from location G152 that was collected from 90 feet bgs contained 52.2  $\mu\text{g/l}$  total target VOCs. However, these concentrations are highly suspect because the hydropunch sampler met refusal after being advanced only 2 feet beyond the augers (advancement of 5 feet is typical). Therefore, once the sample collection chamber was opened (an 11-inch extension), the top of the chamber was only 13 inches below the augers, which is not far enough to isolate the chamber from the conduit formed by the auger. The chamber was not advanced far enough into the undisturbed formation to prevent cross-contamination from areas of higher concentration. This theory is supported by the data available from other elevations at G152. The most concentrated elevation detected at G152 was 122.4  $\mu\text{g/l}$  at 45 feet bgs. The samples from 60 and 75 feet, like samples from other locations, show a decrease in concentrations with increasing depth below 45 feet bgs. The target VOC concentration detected at 90 feet bgs shows an increase in concentration that is not consistent with this trend. The data for the lowermost sample from location G152 (90 feet bgs) was not used in preparing the plume plan views and cross-sections presented in Figures 4-1 through 4-3 and 4-5 through 4-7.

**4.2 PRIVATE IRRIGATION WELL RESULTS.** Groundwater samples were collected from 11 PIWs in the Crooked River Plantation Subdivision (see Figure 2-3) including two PIWs that were also sampled in the initial ICMSI. All PIW samples, and three duplicate samples, were analyzed at an off-site laboratory. Table 4-3 summarizes the analytical data for the PIW samples, providing the concentrations of all constituents that were detected.

The two PIWs that were resampled in January 1993, PW-54 and PW-55, are in locations underlain by the plume (see Figure 2-2). Sample PW-54 did not contain detectable concentrations of VOCs (see Table 4-3). Sample PW-55 contained a detectable concentration of acetone, which is discussed in the following paragraph. VOCs detected in other PIW samples include compounds suspected of being artifacts of laboratory or sampling procedures, compounds common in water treated for public drinking water supply, and solvents.

Two VOCs, acetone and 2-butanone, are common laboratory solvents that are frequently observed artifacts of laboratory procedures, and can be artifacts of sampling procedures when solvents are used in decontamination of sampling equipment. However, no decontamination was performed during sampling of PIWs because samples were collected directly from PIW plumbing fixtures. Acetone was detected in six PIW samples, PW-52, PW-53, PW-55, PW-56, PW-57, and PW-58 (see Table 4-3) at concentrations ranging from an estimated 3 J to 19  $\mu\text{g/l}$ , which could not be qualified based on validation criteria. The occurrence of acetone in these PIWs is sporadic over the area investigated and no correlation to the area of the plume is evident. Therefore, the reported concentrations are either artifacts of laboratory procedures or have a source other than Site 11. 2-Butanone, also a common laboratory solvent, was detected in one PIW sample, PW-61D (see Table 4-3) at a concentration of 5  $\mu\text{g/l}$ . However, because the analysis of replicate sample PW-61 did not contain detectable concentrations of 2-butanone, the concentration reported for duplicate sample PW-61D is suspected as being an artifact of laboratory procedures.

VOCs commonly found in chlorinated public water supplies include bromodichloromethane, dibromochloromethane, and bromoform. These compounds are generally classified as trihalomethanes and are formed in water as a result of chlorination. It is suspected that the occurrence of these VOCs in PIW samples

Table 4-3 Summary of Analytical Data for Private Irrigation Well Samples

Compound	MCL	Well ID Numbers (µg/l)									
		PW-52	PW-53	PW-54	PW-55	PW-55D	PW-56	PW-57	PW-58	PW-59	PW-59D
Acetone	NA	3 J	4 J	5 U	19	32 U	9	4 J	4 J	5 U	5 U
Carbon Disulfide	NA	130	1 U	1 U	1 U	1 U	4	1 U	1 U	1 U	1 U
2-Butanone	NA	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	NA	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	16	16
Trichloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	60	1 U	1 U	1 U
Dibromochloromethane	NA	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	14	14
Bromoform	100	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	3	2
Toluene	1,000	1 U	1 U	1 U	1 U	1 U	1 U	1	1 U	1 U	1 U
Styrene	100	1 U	1 U	1 U	1 U	1 U	1 U	8	1 U	1 U	1 U

Compound	MCL	Sample ID Numbers (µg/l)			
		PW-60	PW-61	PW-61D	PW-62
Acetone	NA	21 U	14 U	16 U	5 U
Carbon Disulfide	NA	150	1 U	1 U	3
2- Butanone	NA	5 U	5 U	5	5 U
Bromodichloromethane	NA	1 U	1 U	1 U	1 U
Trichloroethene	5	1 U	1 U	1 U	1 U
Dibromochloromethane	NA	1 U	1 U	1 U	1 U
Bromoform	100	1 U	1 U	1 U	1 U
Toluene	1,000	1 U	1 U	1 U	1 U
Styrene	100	1 U	1 U	1 U	1 U

Notes: J = sample result is considered estimated because concentration exceeded the linear range of the instrument  
 U = compounds not detected at the stated quantitation limit  
 MCL = Maximum Contaminant Level, USEPA Office of Water, December 1992; The Bureau of National Affairs, Inc., July 1992.

is related to land application of city water in the area of the PIW samples. The occurrence of these compounds in PIW samples is also sporadic and does not appear to be related to Site 11.

Sample PW-57 contained trichloroethene, styrene, and toluene, which are solvents. Sample PW-57 is from a PIW that was also sampled in the initial ICMSI (previously CRP-PW-36) when trichloroethene was also found at this location (toluene and styrene were not). However, this PIW is located approximately 1,600 feet southwest of the site and is not likely to be influenced by the plume from the landfill. The presence of trichloroethene at this location is not attributed to the site.

One other VOC was detected in PIW samples collected during the January 1993 sampling event. Carbon disulfide was detected in four PIW samples at concentrations ranging from 3 to 150  $\mu\text{g/l}$ . The marsh deposits common to the Kings Bay area are a natural source of sulfur compounds that can be a food source for bacteria. The presence of carbon disulfide in groundwater is considered to be a by-product of the metabolism of sulfur compounds by indigenous bacteria (Verschueren, 1983).

## 5.0 SUMMARY

The follow-on ICMSI field activities reported in this addendum were conducted to evaluate groundwater VOC contamination beneath the Old Camden County Landfill. Additionally, 11 PIWs were sampled, including two PIWs previously sampled, to evaluate VOCs in irrigation water that are potentially related to groundwater contamination associated with releases from the landfill. The results of these follow-on investigations are summarized in the paragraphs below.

Data from on-site analysis of 10 target VOCs in groundwater samples collected from the landfill using hydropunch equipment indicate that the plume is similar in composition over its entire area. Vinyl chloride and cis-1,2-dichloroethene are the primary halogenated VOCs present, and benzene, toluene, ethylbenzene, and xylenes are characteristic fuel-related VOCs in the plume. The same five VOCs detected above Federal MCLs in the samples collected during the ICMSI were also detected in groundwater samples collected during follow-on sampling activities in the landfill. The five VOCs are vinyl chloride, trichloroethene, cis-1,2-dichloroethene, tetrachloroethene, and benzene. The MCLs for these compounds are 2, 70, 5, 5, and 5  $\mu\text{g/l}$ , respectively.

The on-site laboratory data were compiled into the database developed from data collected during the initial ICMSI, which focused on VOC contamination in groundwater along and downgradient of the western margin of the landfill in the direction of groundwater flow. The plume plan views and cross-sections presented in Figures 4-1 through 4-3 and 4-5 through 4-7 were developed using data from the Phase I Interim Investigation (August 1992), the initial ICMSI (October and November 1992), and the data presented in this addendum. The isoconcentration contours in the plume plan views and cross-sections represent concentrations of total target VOCs. As can be seen in these figures, the concentrations of VOCs beneath the landfill are generally less than those detected from locations along the western margin of the landfill and extending to the western right of Spur 40. This may indicate the source of the VOCs is near the western margin of the landfill or that the source is depleted and the majority of VOCs have migrated away from the source.

One or more of the 11 PIW samples collected in January 1993 contained detectable concentrations of VOCs that are attributed to incidental contamination during laboratory procedures (acetone and 2-butanone), trihalomethanes that commonly result from the chlorination of drinking water supplies (bromoform, bromodichloromethane, and dibromochloromethane), and solvents (trichloroethene, toluene, and styrene). The occurrence of VOCs in the 11 PIW samples was sporadic, and with the exception of acetone detected in sample PW-55, none of these VOCs were detected in samples from locations known to be underlain by the plume. One sample also contained carbon disulfide, which is suspected of being naturally occurring. The analytical data indicates that plume contaminants were not present in the PIW samples.

## **Appendix A**

### **Private Irrigation Well Survey Forms**

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? 2 years 7 months  
 Do you own the house or rent it? own  
 If rented, who owns the house?  
 Their mailing address?
  
2. Do you have a private well? yes  
 (Any water source other than a metered, public water supply).
  
3. What kind of well is it? shallow ground water  
 Please describe it as best you can. (Location in yard, depth, type of pump).  
Back yard, 24 ft. suction
  
4. Do you know who installed your well? yes  
 When? July 1990
  
5. Please use the chart below to indicate how you have used your well water, how often and when.  
 Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input type="checkbox"/> Filling Swimming Pool		
<input type="checkbox"/> Garden Watering		
<input checked="" type="checkbox"/> Lawn Watering	<u>Approx. 2</u>	<u>normally 12-6 pm</u>
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input type="checkbox"/> Washing Cars and Yard Items		
<input type="checkbox"/> Other, please specify: _____ _____ _____		

6. Do you use a hose with your private well water? yes  
 For what kind of activities? watering lawn
  
7. Do you have a sprinkler system? yes How many sprinkler heads? 14  
 What type and number of spigots do you have on each system? 1 hose type  
 What are their positions in the yard? Back yard by Porch

## WELL TEST CONSENT FORM

To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

1. Upon receipt of this completed Consent Form, you will be contacted to establish a date and time for the sampling. (The sampling needs to take place by early November.)
2. An ABB Environmental Services, Inc. (ABB-ES) staff member will meet you at the agreed date and time to take 3-9 samples from your well. The sampling will require up to 2 hours time.
3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

RUSSELL  
[Signature]  
Signature

309 Woodhouse Dr  
Address

882-2213  
Phone

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

Federal law gives you the right to obtain a portion of any water or soil sample that the Navy may draw from your property. This is what is normally referred to as a "split sample." Should you request a split sample, you will be responsible for providing a container(s) for the split sample(s) and will be responsible for all costs associated with analyzing your portion of the sample(s). The Navy will be responsible for its portion of the sample(s) and will bear all costs associated with analyzing its portion. Federal law also gives you the right to obtain a copy of the results of the Navy's analysis of any samples it draws from your property. Unless you indicate to us that you do not desire to receive a copy of the results, a copy will be provided to you without charge.

Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? 4 YRS  
 Do you own the house or rent it? OWN  
 If rented, who owns the house?  
 Their mailing address?
  
2. Do you have a private well? yes  
 (Any water source other than a metered, public water supply).
  
3. What kind of well is it? BACK YARD, 20 FOOT, 1 1/2 HP  
 Please describe it as best you can. (Location in yard, depth, type of pump).
  
4. Do you know who installed your well? ME  
 When? 1990
  
5. Please use the chart below to indicate how you have used your well water, how often and when.  
 Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input type="checkbox"/> Filling Swimming Pool		
<input type="checkbox"/> Garden Watering		
<input checked="" type="checkbox"/> Lawn Watering	<u>4-6</u>	<u>1700 - 1900</u>
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input type="checkbox"/> Washing Cars and Yard Items		
<input type="checkbox"/> Other, please specify: _____ _____ _____		

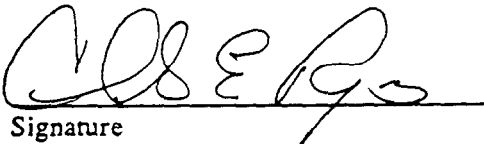
6. Do you use a hose with your private well water? yes  
 For what kind of activities? WASH PATIO
  
7. Do you have a sprinkler system? yes How many sprinkler heads? 12  
 What type and number of spigots do you have on each system? PVC 3 VALVES  
 What are their positions in the yard? BACK YARD / ALONG SIDE PUMP.

## WELL TEST CONSENT FORM

To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

1. Upon receipt of this completed Consent Form, you will be contacted to establish a date and time for the sampling. (The sampling needs to take place by early November.)
2. An ABB Environmental Services, Inc. (ABB-ES) staff member will meet you at the agreed date and time to take 3-9 samples from your well. The sampling will require up to 2 hours time.
3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

  
Signature

213 PLANTATION COURT  
Address

882-4015  
Phone

Work 673-3810

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

Federal law gives you the right to obtain a portion of any water or soil sample that the Navy may draw from your property. This is what is normally referred to as a "split sample." Should you request a split sample, you will be responsible for providing a container(s) for the split sample(s) and will be responsible for all costs associated with analyzing your portion of the sample(s). The Navy will be responsible for its portion of the sample(s) and will bear all costs associated with analyzing its portion. Federal law also gives you the right to obtain a copy of the results of the Navy's analysis of any samples it draws from your property. Unless you indicate to us that you do not desire to receive a copy of the results, a copy will be provided to you without charge.

Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? 4 1/2 yrs  
 Do you own the house or rent it? own  
 If rented, who owns the house?  
 Their mailing address?
  
2. Do you have a private well? yes  
 (Any water source other than a metered, public water supply).
  
3. What kind of well is it? shallow well  
 Please describe it as best you can. (Location in yard, depth, type of pump).  
close to house. one pump 20' deep.
  
4. Do you know who installed your well? self  
 When? 24 no ago.
  
5. Please use the chart below to indicate how you have used your well water, how often and when.  
 Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input checked="" type="checkbox"/> Filling Swimming Pool	<u>2 to 3</u>	<u>AM and PM</u>
<input checked="" type="checkbox"/> Garden Watering	<u>2</u>	<u>evening</u>
<input checked="" type="checkbox"/> Lawn Watering	<u>same</u>	<u>same</u>
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input checked="" type="checkbox"/> Washing Cars and Yard Items	<u>1</u>	<u>afternoon</u>
<input type="checkbox"/> Other, please specify: _____ _____ _____		

6. Do you use a hose with your private well water? yes  
 For what kind of activities?
  
7. Do you have a sprinkler system? no How many sprinkler heads? \_\_\_\_\_  
 What type and number of spigots do you have on each system? \_\_\_\_\_  
 What are their positions in the yard?

## WELL TEST CONSENT FORM

To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

1. Upon receipt of this completed Consent Form, you will be contacted to establish a date and time for the sampling. (The sampling needs to take place by early November.)
2. An ABB Environmental Services, Inc. (ABB-ES) staff member will meet you at the agreed date and time to take 3-9 samples from your well. The sampling will require up to 2 hours time.
3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

Samuel C. Rodenhauer  
Signature

106 Cherry Point Dr.  
Address

882-6658  
Phone

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

Federal law gives you the right to obtain a portion of any water or soil sample that the Navy may draw from your property. This is what is normally referred to as a "split sample." Should you request a split sample, you will be responsible for providing a container(s) for the split sample(s) and will be responsible for all costs associated with analyzing your portion of the sample(s). The Navy will be responsible for its portion of the sample(s) and will bear all costs associated with analyzing its portion. Federal law also gives you the right to obtain a copy of the results of the Navy's analysis of any samples it draws from your property. Unless you indicate to us that you do not desire to receive a copy of the results, a copy will be provided to you without charge.

Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? 1.5 yrs  
 Do you own the house or rent it?  
 If rented, who owns the house?  
 Their mailing address? H
  
2. Do you have a private well? yes  
 (Any water source other than a metered, public water supply).
  
3. What kind of well is it? 1.5 ft  
 Please describe it as best you can. (Location in yard, depth, type of pump).
  
4. Do you know who installed your well?  
 When? N/A
  
5. Please use the chart below to indicate how you have used your well water, how often and when.  
 Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input type="checkbox"/> Filling Swimming Pool		
<input checked="" type="checkbox"/> Garden Watering	<u>3</u>	
<input checked="" type="checkbox"/> Lawn Watering	<u>3</u>	<u>evening</u>
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input checked="" type="checkbox"/> Washing Cars and Yard Items	<u>1</u>	
<input type="checkbox"/> Other, please specify: _____ _____ _____		


6. Do you use a hose with your private well water? yes  
 For what kind of activities? lawn
  
7. Do you have a sprinkler system? yes How many sprinkler heads? 5  
 What type and number of spigots do you have on each system? 1  
 What are their positions in the yard? each corner of back yard  
front for front

## WELL TEST CONSENT FORM

To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

1. Upon receipt of this completed Consent Form, you will be contacted to establish a date and time for the sampling. (The sampling needs to take place by early November.)
2. An ABB Environmental Services, Inc. (ABB-ES) staff member will meet you at the agreed date and time to take 3-9 samples from your well. The sampling will require up to 2 hours time.
3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

  
Signature

  
Address

  
Phone

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

Federal law gives you the right to obtain a portion of any water or soil sample that the Navy may draw from your property. This is what is normally referred to as a "split sample." Should you request a split sample, you will be responsible for providing a container(s) for the split sample(s) and will be responsible for all costs associated with analyzing your portion of the sample(s). The Navy will be responsible for its portion of the sample(s) and will bear all costs associated with analyzing its portion. Federal law also gives you the right to obtain a copy of the results of the Navy's analysis of any samples it draws from your property. Unless you indicate to us that you do not desire to receive a copy of the results, a copy will be provided to you without charge.

Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? ≈ 1.5 years  
 Do you own the house or rent it? Own  
 If rented, who owns the house?  
 Their mailing address?
  
2. Do you have a private well? yes  
 (Any water source other than a metered, public water supply).
  
3. What kind of well is it? Sho  
 Please describe it as best you can. (Location in yard, depth, type of pump).
  
4. Do you know who installed your well? former owner  
 When?
  
5. Please use the chart below to indicate how you have used your well water, how often and when. Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input type="checkbox"/> Filling Swimming Pool		
<input type="checkbox"/> Garden Watering		
<input checked="" type="checkbox"/> Lawn Watering	<u>once/twice max</u>	<u>Evening</u>
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input type="checkbox"/> Washing Cars and Yard Items		
<input type="checkbox"/> Other, please specify: _____ _____ _____		

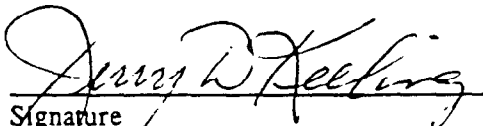
6. Do you use a hose with your private well water? No  
 For what kind of activities?
  
7. Do you have a sprinkler system? Yes How many sprinkler heads? 215  
 What type and number of spigots do you have on each system? Rainbird  
 What are their positions in the yard?

## WELL TEST CONSENT FORM

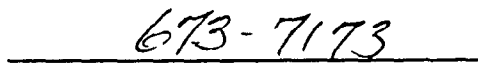
To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

1. Upon receipt of this completed Consent Form, you will be contacted to establish a date and time for the sampling. (The sampling needs to take place by early November.)
2. An ABB Environmental Services, Inc. (ABB-ES) staff member will meet you at the agreed date and time to take 3-9 samples from your well. The sampling will require up to 2 hours time.
3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

  
Signature

  
Address

  
Phone

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

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Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? 4 years  
Do you own the house or rent it? own  
If rented, who owns the house?  
Their mailing address?
2. Do you have a private well? yes  
(Any water source other than a metered, public water supply).
3. What kind of well is it? SHALLOW SPRINKLER, REAR OF YARD, 25' DEEP  
Please describe it as best you can. (Location in yard, depth, type of pump).
4. Do you know who installed your well? Self  
When? 1989
5. Please use the chart below to indicate how you have used your well water, how often and when. Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input type="checkbox"/> Filling Swimming Pool		
<input checked="" type="checkbox"/> Garden Watering	<u>5</u>	<u>AM + PM</u>
<input checked="" type="checkbox"/> Lawn Watering	<u>2</u>	<u>AM</u>
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input type="checkbox"/> Washing Cars and Yard Items		
<input type="checkbox"/> Other, please specify: _____ _____ _____		

6. Do you use a hose with your private well water? NO  
For what kind of activities?
7. Do you have a sprinkler system? Yes How many sprinkler heads? 12  
What type and number of spigots do you have on each system? \_\_\_\_\_  
What are their positions in the yard?

## WELL TEST CONSENT FORM

To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

1. Upon receipt of this completed Consent Form, you will be contacted to establish a date and time for the sampling. (The sampling needs to take place by early November.)
2. An ABB Environmental Services, Inc. (ABB-ES) staff member will meet you at the agreed date and time to take 3-9 samples from your well. The sampling will require up to 2 hours time.
3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

Rodney J. Gibbens  
Signature

301 CHERRY PT  
Address

882 3149  
Phone

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

Federal law gives you the right to obtain a portion of any water or soil sample that the Navy may draw from your property. This is what is normally referred to as a "split sample." Should you request a split sample, you will be responsible for providing a container(s) for the split sample(s) and will be responsible for all costs associated with analyzing your portion of the sample(s). The Navy will be responsible for its portion of the sample(s) and will bear all costs associated with analyzing its portion. Federal law also gives you the right to obtain a copy of the results of the Navy's analysis of any samples it draws from your property. Unless you indicate to us that you do not desire to receive a copy of the results, a copy will be provided to you without charge.

Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? 2 yrs.  
Do you own the house or rent it? Own  
If rented, who owns the house?  
Their mailing address?
2. Do you have a private well? yes  
(Any water source other than a metered, public water supply).
3. What kind of well is it? Shallow, west side of house, 30', 1/2 horse pump  
Please describe it as best you can. (Location in yard, depth, type of pump).
4. Do you know who installed your well? yes  
When? Oct 1990
5. Please use the chart below to indicate how you have used your well water, how often and when.  
Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input type="checkbox"/> Filling Swimming Pool		
<input type="checkbox"/> Garden Watering		
<input checked="" type="checkbox"/> Lawn Watering	<u>3-4</u>	<u>morning &amp; evening</u>
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input type="checkbox"/> Washing Cars and Yard Items		
<input type="checkbox"/> Other, please specify: _____ _____ _____		

6. Do you use a hose with your private well water? no  
For what kind of activities?
7. Do you have a sprinkler system? yes How many sprinkler heads? 21  
What type and number of spigots do you have on each system? none  
What are their positions in the yard?

## WELL TEST CONSENT FORM

To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

1. Upon receipt of this completed Consent Form, you will be contacted to establish a date and time for the sampling. (The sampling needs to take place by early November.)
2. An ABB Environmental Services, Inc. (ABB-ES) staff member will meet you at the agreed date and time to take 3-9 samples from your well. The sampling will require up to 2 hours time.
3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

Joseph M. Drury  
Signature

204 Cottage Ct., St Marys, Ga. 31558  
Address

882-4741  
Phone

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

Federal law gives you the right to obtain a portion of any water or soil sample that the Navy may draw from your property. This is what is normally referred to as a "split sample." Should you request a split sample, you will be responsible for providing a container(s) for the split sample(s) and will be responsible for all costs associated with analyzing your portion of the sample(s). The Navy will be responsible for its portion of the sample(s) and will bear all costs associated with analyzing its portion. Federal law also gives you the right to obtain a copy of the results of the Navy's analysis of any samples it draws from your property. Unless you indicate to us that you do not desire to receive a copy of the results, a copy will be provided to you without charge.

Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? *3 years*  
Do you own the house or rent it? *own*  
If rented, who owns the house?  
Their mailing address?
  
2. Do you have a private well? *yes*  
(Any water source other than a metered, public water supply).
  
3. What kind of well is it? *Shallow*  
Please describe it as best you can. (Location in yard, depth, type of pump).  
*20 feet deep in front of house, 5 feet from house, 10 feet from house*
  
4. Do you know who installed your well? *yes*  
When? *1971*
  
5. Please use the chart below to indicate how you have used your well water, how often and when.  
Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input type="checkbox"/> Filling Swimming Pool		
<input checked="" type="checkbox"/> Garden Watering		
<input checked="" type="checkbox"/> Lawn Watering		
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input type="checkbox"/> Washing Cars and Yard Items		
<input type="checkbox"/> Other, please specify: _____ _____ _____		


6. Do you use a hose with your private well water? yes  
For what kind of activities? watering yard & garden
7. Do you have a sprinkler system? no How many sprinkler heads? \_\_\_\_\_  
What type and number of spigots do you have on each system? \_\_\_\_\_  
What are their positions in the yard? \_\_\_\_\_


## WELL TEST CONSENT FORM

To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

1. Upon receipt of this completed Consent Form, you will be contacted to establish a date and time for the sampling. (The sampling needs to take place by early November.)
2. An ABB Environmental Services, Inc. (ABB-ES) staff member will meet you at the agreed date and time to take 3-9 samples from your well. The sampling will require up to 2 hours time.
3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

  
Signature

  
Address

  
Phone

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

Federal law gives you the right to obtain a portion of any water or soil sample that the Navy may draw from your property. This is what is normally referred to as a "split sample." Should you request a split sample, you will be responsible for providing a container(s) for the split sample(s) and will be responsible for all costs associated with analyzing your portion of the sample(s). The Navy will be responsible for its portion of the sample(s) and will bear all costs associated with analyzing its portion. Federal law also gives you the right to obtain a copy of the results of the Navy's analysis of any samples it draws from your property. Unless you indicate to us that you do not desire to receive a copy of the results, a copy will be provided to you without charge.

Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? 2  
Do you own the house or rent it? OWN  
If rented, who owns the house?  
Their mailing address?
2. Do you have a private well? YES  
(Any water source other than a metered, public water supply).
3. What kind of well is it? SHALLOW WELL  
Please describe it as best you can. (Location in yard, depth, type of pump).
4. Do you know who installed your well?  
When? I INSTALLED, 1989
5. Please use the chart below to indicate how you have used your well water, how often and when. Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input type="checkbox"/> Filling Swimming Pool		
<input checked="" type="checkbox"/> Garden Watering	<u>4 TO 5</u>	<u>EARLY MORNING</u>
<input checked="" type="checkbox"/> Lawn Watering	<u>4 TO 5</u>	<u>" "</u>
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input type="checkbox"/> Washing Cars and Yard Items		
<input type="checkbox"/> Other, please specify: _____ _____ _____		

6. Do you use a hose with your private well water? NO  
  
For what kind of activities?
7. Do you have a sprinkler system? YES How many sprinkler heads? 27  
What type and number of spigots do you have on each system?  
What are their positions in the yard? COMPLETE BACK YARD COVERAGE, PARTIAL SIDE/FRONT

## WELL TEST CONSENT FORM

To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

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3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

Larry W Wallace  
Signature

204 PLANTATION CT.  
Address

882-7887  
Phone

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

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Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

## PRIVATE WELL SURVEY

Thank you for participating in this brief survey. Your input will help identify potential problems associated with the use of groundwater in the area. Your responses will be held in confidence, only to be used by the project team working on the groundwater investigation. (See other side when complete)

1. How long have you lived in your current home? 4 yrs  
 Do you own the house or rent it?  
 If rented, who owns the house?  
 Their mailing address?
  
2. Do you have a private well? yes  
 (Any water source other than a metered, public water supply).
  
3. What kind of well is it? Shallow well 25 feet 1 HP Pump  
 Please describe it as best you can. (Location in yard, depth, type of pump).  
on North side of house
  
4. Do you know who installed your well? Self  
 When? 3 yrs
  
5. Please use the chart below to indicate how you have used your well water, how often and when.  
 Check the box if the activity applies to your home, then complete the line.

Activity	Times per Week	Time of Day
<input type="checkbox"/> Filling Swimming Pool		
<input type="checkbox"/> Garden Watering		
<input checked="" type="checkbox"/> Lawn Watering	<u>2</u>	<u>late afternoon</u>
<input type="checkbox"/> Drinking Water for Adults, Children, Animals		
<input type="checkbox"/> Washing Cars and Yard Items		
<input type="checkbox"/> Other, please specify: _____ _____ _____		

6. Do you use a hose with your private well water? yes  
 For what kind of activities? sprinkler to water lawn
  
7. Do you have a sprinkler system? No How many sprinkler heads? \_\_\_\_\_  
 What type and number of spigots do you have on each system? \_\_\_\_\_  
 What are their positions in the yard?

## WELL TEST CONSENT FORM

To gather information on the location and concentration of the plume, we are asking your permission to sample your private well. This sampling process will be conducted at no expense to you and the data will provide a better understanding of groundwater quality in your area. The process is as follows:

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3. Results from your well test will be made available to you, through the U.S. Navy, after laboratory analysis and validation. This process can take several weeks.

With this understanding, I do allow the U.S. Navy, including its consultant, ABB-ES and their subcontractors, access my property and sample my well.

Milda Vazquez  
Signature

310 Fairfield Drive  
Address St Marys Ga 31558

882-4113  
Phone

Please return this form at the public meeting or mail it to Public Affairs Office, Subase King's Bay, GA 31547-5015 on or by October 15, 1992. Please keep one copy of this completed form for your records.

### Property Owner Advisement

Federal law gives you the right to obtain a portion of any water or soil sample that the Navy may draw from your property. This is what is normally referred to as a "split sample." Should you request a split sample, you will be responsible for providing a container(s) for the split sample(s) and will be responsible for all costs associated with analyzing your portion of the sample(s). The Navy will be responsible for its portion of the sample(s) and will bear all costs associated with analyzing its portion. Federal law also gives you the right to obtain a copy of the results of the Navy's analysis of any samples it draws from your property. Unless you indicate to us that you do not desire to receive a copy of the results, a copy will be provided to you without charge.

Statutory Authority Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Sec. 9604(4)(B).

# **Appendix B**

## **Validated Analytical Data Tables**

## DEFINITION OF DATA QUALIFIERS

### Organic Data Qualifiers

- J - Indicates an estimated concentration because results are either below the concentration required detection level (CRQL) or quality control criteria were not met.
- U - Indicates that compound was analyzed but not detected.
- UJ - Indicates that quantitation level was estimated because QC criteria were not met.
- NJ - Presumptive evidence for the presence of a compound at an estimated value.
- E - Indicates that the analyte concentration exceeded the calibration range of the GC/MS and re-analysis of diluted sample within calibration range.
- D - Indicates that sample concentration was obtained by dilution to bring result within calibration range.
- X - Total concentration of two indistinguishable isomers (i.e., 3-Methylphenol and 4-Methylphenol).
- UR - Indicates that the reported detection limit is unusable because QA criteria were not met.

### Inorganic Data Qualifiers

- J - Indicates an estimated concentration because results are either below the concentration required detection level (CRQL) or quality control criteria were not met.
- U - Indicates that compound was analyzed but not detected.
- UJ - Indicates that quantitation level was estimated because QC criteria were not met.
- E - The reported concentration is estimated because of the presence of an interference.
- UR - Indicates that the reported detection limit is unusable because QC criteria were not met.

**Hydropunch Groundwater Samples  
March 1993**

PROJECT: NSB KINGSBAY, GEORGIA

## VOLATILE AQUEOUS ANALYSES (ug/l)

## VALIDATION SUMMARY TABLE

SAMPLE NUMBER:	11G15030	11G15230	11G15230D	11G15885	11G15940	11G16035
LAB NUMBER:	35388001	35388006	35388007	35433003	35442002	35442003
DATE SAMPLED:	03/17/93	03/17/93	03/17/93	03/22/93	03/23/93	03/23/93
DATE ANALYZED:	03/24/93	03/23/93	03/24/93	03/29/93	03/30/93	03/30/93
DILUTION FACTOR:	1	1	1	1	1	1

Compound	CRQL						
Chloromethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Vinyl chloride	1	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	2	2 U	37	41	2 U	2 U	3
Acetone	5	5 U	280	310	800	5 U	24 U
Carbon disulfide	1	3	200	250	1 U	1 U	3
1,1-Dichloroethene	1	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1	1 U	12	14	1 U	1 U	17
cis-1,2-Dichloroethene	1	1 U	2	2	1 U	6	22
trans-1,2-Dichloroethene	1	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1	1 U	1 U	1 U	3	1 U	1 U
1,2-Dichloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone	5	5 U	440	480	5 U	5 U	5 U
1,1,1-Trichloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Carbon Tetrachloride	1	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	1	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	1	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	1	1 U	3	3	1 U	1 U	3
Dibromochloromethane	1	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	1	1 U	1	1	1 U	1 U	5
trans-1,3-Dichloropropene	1	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1	1 U	1 U	1 U	1 U	1 U	1 U
2-Hexanone	5	5 U	19	17	5 U	5 U	5 U
4-Methyl-2-Pentanone	5	5 U	100	110	5 U	5 U	5 U
Tetrachloroethene	1	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1	1 U	720	840	2	1 U	11
Chlorobenzene	1	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1	1 U	16	18	1 U	15	6
Styrene	1	1 U	1 U	1 U	1 U	1 U	1 U
Xylene (total)	1	1 U	62	67	1 U	12	14
1,3-Dichlorobenzene	1	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1	1 U	1 U	1 U	1 U	3	1 U
1,2-Dichlorobenzene	1	1 U	1 U	1 U	1 U	1 U	1 U

B-1

**Private Irrigation Well Samples  
January 1993**

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858001	CRPPW52	01/12/93	Chloromethane	1 U
34858001	CRPPW52	01/12/93	Bromomethane	1 U
34858001	CRPPW52	01/12/93	Vinyl chloride	1 U
34858001	CRPPW52	01/12/93	Chloroethane	1 U
34858001	CRPPW52	01/12/93	Methylene chloride	2 U
34858001	CRPPW52	01/12/93	Acetone	3 J
34858001	CRPPW52	01/12/93	Carbon disulfide	130
34858001	CRPPW52	01/12/93	1,1-Dichloroethene	1 U
34858001	CRPPW52	01/12/93	1,1-Dichloroethane	1 U
34858001	CRPPW52	01/12/93	cis-1,2-Dichloroethene	1 U
34858001	CRPPW52	01/12/93	trans-1,2-Dichloroethene	1 U
34858001	CRPPW52	01/12/93	Chloroform	1 U
34858001	CRPPW52	01/12/93	1,2-Dichloroethane	1 U
34858001	CRPPW52	01/12/93	2-Butanone	5 U
34858001	CRPPW52	01/12/93	1,1,1-Trichloroethane	1 U
34858001	CRPPW52	01/12/93	Carbon tetrachloride	1 U
34858001	CRPPW52	01/12/93	Bromodichloromethane	1 U
34858001	CRPPW52	01/12/93	1,2-Dichloropropane	1 U
34858001	CRPPW52	01/12/93	cis-1,3-Dichloropropane	1 U
34858001	CRPPW52	01/12/93	Trichloroethene	1 U
34858001	CRPPW52	01/12/93	Dibromochloromethane	1 U
34858001	CRPPW52	01/12/93	1,1,2-Trichloroethane	1 U
34858001	CRPPW52	01/12/93	Benzene	1 U
34858001	CRPPW52	01/12/93	trans-1,3-Dichloropropene	1 U
34858001	CRPPW52	01/12/93	Bromoform	1 U
34858001	CRPPW52	01/12/93	2-Hexanone	5 U
34858001	CRPPW52	01/12/93	4-Methyl-2-pentanone	5 U
34858001	CRPPW52	01/12/93	Tetrachloroethene	1 U
34858001	CRPPW52	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858001	CRPPW52	01/12/93	Toluene	1 U
34858001	CRPPW52	01/12/93	Chlorobenzene	1 U
34858001	CRPPW52	01/12/93	Ethylbenzene	1 U
34858001	CRPPW52	01/12/93	Styrene	1 U
34858001	CRPPW52	01/12/93	Xylenes (total)	1 U
34858001	CRPPW52	01/12/93	1,3-Dichlorobenzene	1 U
34858001	CRPPW52	01/12/93	1,4-Dichlorobenzene	1 U
34858001	CRPPW52	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/15/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858002	CRPPW53	01/12/93	Chloromethane	1 U
34858002	CRPPW53	01/12/93	Bromomethane	1 U
34858002	CRPPW53	01/12/93	Vinyl chloride	1 U
34858002	CRPPW53	01/12/93	Chloroethane	1 U
34858002	CRPPW53	01/12/93	Methylene chloride	2 U
34858002	CRPPW53	01/12/93	Acetone	4 J
34858002	CRPPW53	01/12/93	Carbon disulfide	1 U
34858002	CRPPW53	01/12/93	1,1-Dichloroethene	1 U
34858002	CRPPW53	01/12/93	1,1-Dichloroethane	1 U
34858002	CRPPW53	01/12/93	cis-1,2-Dichloroethene	1 U
34858002	CRPPW53	01/12/93	trans-1,2-Dichloroethene	1 U
34858002	CRPPW53	01/12/93	Chloroform	1 U
34858002	CRPPW53	01/12/93	1,2-Dichloroethane	1 U
34858002	CRPPW53	01/12/93	2-Butanone	5 U
34858002	CRPPW53	01/12/93	1,1,1-Trichloroethane	1 U
34858002	CRPPW53	01/12/93	Carbon tetrachloride	1 U
34858002	CRPPW53	01/12/93	Bromodichloromethane	1 U
34858002	CRPPW53	01/12/93	1,2-Dichloropropane	1 U
34858002	CRPPW53	01/12/93	cis-1,3-Dichloropropane	1 U
34858002	CRPPW53	01/12/93	Trichloroethene	1 U
34858002	CRPPW53	01/12/93	Dibromochloromethane	1 U
34858002	CRPPW53	01/12/93	1,1,2-Trichloroethane	1 U
34858002	CRPPW53	01/12/93	Benzene	1 U
34858002	CRPPW53	01/12/93	trans-1,3-Dichloropropene	1 U
34858002	CRPPW53	01/12/93	Bromoform	1 U
34858002	CRPPW53	01/12/93	2-Hexanone	5 U
34858002	CRPPW53	01/12/93	4-Methyl-2-pentanone	5 U
34858002	CRPPW53	01/12/93	Tetrachloroethene	1 U
34858002	CRPPW53	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858002	CRPPW53	01/12/93	Toluene	1 U
34858002	CRPPW53	01/12/93	Chlorobenzene	1 U
34858002	CRPPW53	01/12/93	Ethylbenzene	1 U
34858002	CRPPW53	01/12/93	Styrene	1 U
34858002	CRPPW53	01/12/93	Xylenes (total)	1 U
34858002	CRPPW53	01/12/93	1,3-Dichlorobenzene	1 U
34858002	CRPPW53	01/12/93	1,4-Dichlorobenzene	1 U
34858002	CRPPW53	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/14/93

Dilution Factor: 1.0

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**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858003	CRPPW54	01/12/93	Chloromethane	1 U
34858003	CRPPW54	01/12/93	Bromomethane	1 U
34858003	CRPPW54	01/12/93	Vinyl chloride	1 U
34858003	CRPPW54	01/12/93	Chloroethane	1 U
34858003	CRPPW54	01/12/93	Methylene chloride	2 U
34858003	CRPPW54	01/12/93	Acetone	5 U
34858003	CRPPW54	01/12/93	Carbon disulfide	1 U
34858003	CRPPW54	01/12/93	1,1-Dichloroethene	1 U
34858003	CRPPW54	01/12/93	1,1-Dichloroethane	1 U
34858003	CRPPW54	01/12/93	cis-1,2-Dichloroethene	1 U
34858003	CRPPW54	01/12/93	trans-1,2-Dichloroethene	1 U
34858003	CRPPW54	01/12/93	Chloroform	1 U
34858003	CRPPW54	01/12/93	1,2-Dichloroethane	1 U
34858003	CRPPW54	01/12/93	2-Butanone	5 U
34858003	CRPPW54	01/12/93	1,1,1-Trichloroethane	1 U
34858003	CRPPW54	01/12/93	Carbon tetrachloride	1 U
34858003	CRPPW54	01/12/93	Bromodichloromethane	1 U
34858003	CRPPW54	01/12/93	1,2-Dichloropropane	1 U
34858003	CRPPW54	01/12/93	cis-1,3-Dichloropropane	1 U
34858003	CRPPW54	01/12/93	Trichloroethene	1 U
34858003	CRPPW54	01/12/93	Dibromochloromethane	1 U
34858003	CRPPW54	01/12/93	1,1,2-Trichloroethane	1 U
34858003	CRPPW54	01/12/93	Benzene	1 U
34858003	CRPPW54	01/12/93	trans-1,3-Dichloropropene	1 U
34858003	CRPPW54	01/12/93	Bromoform	1 U
34858003	CRPPW54	01/12/93	2-Hexanone	5 U
34858003	CRPPW54	01/12/93	4-Methyl-2-pentanone	5 U
34858003	CRPPW54	01/12/93	Tetrachloroethene	1 U
34858003	CRPPW54	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858003	CRPPW54	01/12/93	Toluene	1 U
34858003	CRPPW54	01/12/93	Chlorobenzene	1 U
34858003	CRPPW54	01/12/93	Ethylbenzene	1 U
34858003	CRPPW54	01/12/93	Styrene	1 U
34858003	CRPPW54	01/12/93	Xylenes (total)	1 U
34858003	CRPPW54	01/12/93	1,3-Dichlorobenzene	1 U
34858003	CRPPW54	01/12/93	1,4-Dichlorobenzene	1 U
34858003	CRPPW54	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/15/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858004	CRPPW55	01/12/93	Chloromethane	1 U
34858004	CRPPW55	01/12/93	Bromomethane	1 U
34858004	CRPPW55	01/12/93	Vinyl chloride	1 U
34858004	CRPPW55	01/12/93	Chloroethane	1 U
34858004	CRPPW55	01/12/93	Methylene chloride	2 U
34858004	CRPPW55	01/12/93	Acetone	19
34858004	CRPPW55	01/12/93	Carbon disulfide	1 U
34858004	CRPPW55	01/12/93	1,1-Dichloroethene	1 U
34858004	CRPPW55	01/12/93	1,1-Dichloroethane	1 U
34858004	CRPPW55	01/12/93	cis-1,2-Dichloroethene	1 U
34858004	CRPPW55	01/12/93	trans-1,2-Dichloroethene	1 U
34858004	CRPPW55	01/12/93	Chloroform	1 U
34858004	CRPPW55	01/12/93	1,2-Dichloroethane	1 U
34858004	CRPPW55	01/12/93	2-Butanone	5 U
34858004	CRPPW55	01/12/93	1,1,1-Trichloroethane	1 U
34858004	CRPPW55	01/12/93	Carbon tetrachloride	1 U
34858004	CRPPW55	01/12/93	Bromodichloromethane	1 U
34858004	CRPPW55	01/12/93	1,2-Dichloropropane	1 U
34858004	CRPPW55	01/12/93	cis-1,3-Dichloropropane	1 U
34858004	CRPPW55	01/12/93	Trichloroethene	1 U
34858004	CRPPW55	01/12/93	Dibromochloromethane	1 U
34858004	CRPPW55	01/12/93	1,1,2-Trichloroethane	1 U
34858004	CRPPW55	01/12/93	Benzene	1 U
34858004	CRPPW55	01/12/93	trans-1,3-Dichloropropene	1 U
34858004	CRPPW55	01/12/93	Bromoform	1 U
34858004	CRPPW55	01/12/93	2-Hexanone	5 U
34858004	CRPPW55	01/12/93	4-Methyl-2-pentanone	5 U
34858004	CRPPW55	01/12/93	Tetrachloroethene	1 U
34858004	CRPPW55	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858004	CRPPW55	01/12/93	Toluene	1 U
34858004	CRPPW55	01/12/93	Chlorobenzene	1 U
34858004	CRPPW55	01/12/93	Ethylbenzene	1 U
34858004	CRPPW55	01/12/93	Styrene	1 U
34858004	CRPPW55	01/12/93	Xylenes (total)	1 U
34858004	CRPPW55	01/12/93	1,3-Dichlorobenzene	1 U
34858004	CRPPW55	01/12/93	1,4-Dichlorobenzene	1 U
34858004	CRPPW55	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/15/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858005	CRPPW56	01/12/93	Chloromethane	1 U
34858005	CRPPW56	01/12/93	Bromomethane	1 U
34858005	CRPPW56	01/12/93	Vinyl chloride	1 U
34858005	CRPPW56	01/12/93	Chloroethane	1 U
34858005	CRPPW56	01/12/93	Methylene chloride	2 U
34858005	CRPPW56	01/12/93	Acetone	9
34858005	CRPPW56	01/12/93	Carbon disulfide	4
34858005	CRPPW56	01/12/93	1,1-Dichloroethene	1 U
34858005	CRPPW56	01/12/93	1,1-Dichloroethane	1 U
34858005	CRPPW56	01/12/93	cis-1,2-Dichloroethene	1 U
34858005	CRPPW56	01/12/93	trans-1,2-Dichloroethene	1 U
34858005	CRPPW56	01/12/93	Chloroform	1 U
34858005	CRPPW56	01/12/93	1,2-Dichloroethane	1 U
34858005	CRPPW56	01/12/93	2-Butanone	5 U
34858005	CRPPW56	01/12/93	1,1,1-Trichloroethane	1 U
34858005	CRPPW56	01/12/93	Carbon tetrachloride	1 U
34858005	CRPPW56	01/12/93	Bromodichloromethane	1 U
34858005	CRPPW56	01/12/93	1,2-Dichloropropane	1 U
34858005	CRPPW56	01/12/93	cis-1,3-Dichloropropane	1 U
34858005	CRPPW56	01/12/93	Trichloroethene	1 U
34858005	CRPPW56	01/12/93	Dibromochloromethane	1 U
34858005	CRPPW56	01/12/93	1,1,2-Trichloroethane	1 U
34858005	CRPPW56	01/12/93	Benzene	1 U
34858005	CRPPW56	01/12/93	trans-1,3-Dichloropropene	1 U
34858005	CRPPW56	01/12/93	Bromoform	1 U
34858005	CRPPW56	01/12/93	2-Hexanone	5 U
34858005	CRPPW56	01/12/93	4-Methyl-2-pentanone	5 U
34858005	CRPPW56	01/12/93	Tetrachloroethene	1 U
34858005	CRPPW56	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858005	CRPPW56	01/12/93	Toluene	1 U
34858005	CRPPW56	01/12/93	Chlorobenzene	1 U
34858005	CRPPW56	01/12/93	Ethylbenzene	1 U
34858005	CRPPW56	01/12/93	Styrene	1 U
34858005	CRPPW56	01/12/93	Xylenes (total)	1 U
34858005	CRPPW56	01/12/93	1,3-Dichlorobenzene	1 U
34858005	CRPPW56	01/12/93	1,4-Dichlorobenzene	1 U
34858005	CRPPW56	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/15/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858006	CRPPW57	01/12/93	Chloromethane	1 U
34858006	CRPPW57	01/12/93	Bromomethane	1 U
34858006	CRPPW57	01/12/93	Vinyl chloride	1 U
34858006	CRPPW57	01/12/93	Chloroethane	1 U
34858006	CRPPW57	01/12/93	Methylene chloride	2 U
34858006	CRPPW57	01/12/93	Acetone	4 J
34858006	CRPPW57	01/12/93	Carbon disulfide	1 U
34858006	CRPPW57	01/12/93	1,1-Dichloroethene	1 U
34858006	CRPPW57	01/12/93	1,1-Dichloroethane	1 U
34858006	CRPPW57	01/12/93	cis-1,2-Dichloroethene	1 U
34858006	CRPPW57	01/12/93	trans-1,2-Dichloroethene	1 U
34858006	CRPPW57	01/12/93	Chloroform	1 U
34858006	CRPPW57	01/12/93	1,2-Dichloroethane	1 U
34858006	CRPPW57	01/12/93	2-Butanone	5 U
34858006	CRPPW57	01/12/93	1,1,1-Trichloroethane	1 U
34858006	CRPPW57	01/12/93	Carbon tetrachloride	1 U
34858006	CRPPW57	01/12/93	Bromodichloromethane	1 U
34858006	CRPPW57	01/12/93	1,2-Dichloropropane	1 U
34858006	CRPPW57	01/12/93	cis-1,3-Dichloropropane	1 U
34858006	CRPPW57	01/12/93	Trichloroethene	60
34858006	CRPPW57	01/12/93	Dibromochloromethane	1 U
34858006	CRPPW57	01/12/93	1,1,2-Trichloroethane	1 U
34858006	CRPPW57	01/12/93	Benzene	1 U
34858006	CRPPW57	01/12/93	trans-1,3-Dichloropropene	1 U
34858006	CRPPW57	01/12/93	Bromoform	1 U
34858006	CRPPW57	01/12/93	2-Hexanone	5 U
34858006	CRPPW57	01/12/93	4-Methyl-2-pentanone	5 U
34858006	CRPPW57	01/12/93	Tetrachloroethene	1 U
34858006	CRPPW57	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858006	CRPPW57	01/12/93	Toluene	1
34858006	CRPPW57	01/12/93	Chlorobenzene	1 U
34858006	CRPPW57	01/12/93	Ethylbenzene	1 U
34858006	CRPPW57	01/12/93	Styrene	8
34858006	CRPPW57	01/12/93	Xylenes (total)	1 U
34858006	CRPPW57	01/12/93	1,3-Dichlorobenzene	1 U
34858006	CRPPW57	01/12/93	1,4-Dichlorobenzene	1 U
34858006	CRPPW57	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/15/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858007	CRPPW58	01/12/93	Chloromethane	1 U
34858007	CRPPW58	01/12/93	Bromomethane	1 U
34858007	CRPPW58	01/12/93	Vinyl chloride	1 U
34858007	CRPPW58	01/12/93	Chloroethane	1 U
34858007	CRPPW58	01/12/93	Methylene chloride	2 U
34858007	CRPPW58	01/12/93	Acetone	4 J
34858007	CRPPW58	01/12/93	Carbon disulfide	1 U
34858007	CRPPW58	01/12/93	1,1-Dichloroethene	1 U
34858007	CRPPW58	01/12/93	1,1-Dichloroethane	1 U
34858007	CRPPW58	01/12/93	cis-1,2-Dichloroethene	1 U
34858007	CRPPW58	01/12/93	trans-1,2-Dichloroethene	1 U
34858007	CRPPW58	01/12/93	Chloroform	1 U
34858007	CRPPW58	01/12/93	1,2-Dichloroethane	1 U
34858007	CRPPW58	01/12/93	2-Butanone	5 U
34858007	CRPPW58	01/12/93	1,1,1-Trichloroethane	1 U
34858007	CRPPW58	01/12/93	Carbon tetrachloride	1 U
34858007	CRPPW58	01/12/93	Bromodichloromethane	1 U
34858007	CRPPW58	01/12/93	1,2-Dichloropropane	1 U
34858007	CRPPW58	01/12/93	cis-1,3-Dichloropropane	1 U
34858007	CRPPW58	01/12/93	Trichloroethene	1 U
34858007	CRPPW58	01/12/93	Dibromochloromethane	1 U
34858007	CRPPW58	01/12/93	1,1,2-Trichloroethane	1 U
34858007	CRPPW58	01/12/93	Benzene	1 U
34858007	CRPPW58	01/12/93	trans-1,3-Dichloropropene	1 U
34858007	CRPPW58	01/12/93	Bromoform	1 U
34858007	CRPPW58	01/12/93	2-Hexanone	5 U
34858007	CRPPW58	01/12/93	4-Methyl-2-pentanone	5 U
34858007	CRPPW58	01/12/93	Tetrachloroethene	1 U
34858007	CRPPW58	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858007	CRPPW58	01/12/93	Toluene	1 U
34858007	CRPPW58	01/12/93	Chlorobenzene	1 U
34858007	CRPPW58	01/12/93	Ethylbenzene	1 U
34858007	CRPPW58	01/12/93	Styrene	1 U
34858007	CRPPW58	01/12/93	Xylenes (total)	1 U
34858007	CRPPW58	01/12/93	1,3-Dichlorobenzene	1 U
34858007	CRPPW58	01/12/93	1,4-Dichlorobenzene	1 U
34858007	CRPPW58	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/15/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858008	CRPPW59	01/12/93	Chloromethane	1 U
34858008	CRPPW59	01/12/93	Bromomethane	1 U
34858008	CRPPW59	01/12/93	Vinyl chloride	1 U
34858008	CRPPW59	01/12/93	Chloroethane	1 U
34858008	CRPPW59	01/12/93	Methylene chloride	2 U
34858008	CRPPW59	01/12/93	Acetone	5 U
34858008	CRPPW59	01/12/93	Carbon disulfide	1 U
34858008	CRPPW59	01/12/93	1,1-Dichloroethene	1 U
34858008	CRPPW59	01/12/93	1,1-Dichloroethane	1 U
34858008	CRPPW59	01/12/93	cis-1,2-Dichloroethene	1 U
34858008	CRPPW59	01/12/93	trans-1,2-Dichloroethene	1 U
34858008	CRPPW59	01/12/93	Chloroform	11 U
34858008	CRPPW59	01/12/93	1,2-Dichloroethane	1 U
34858008	CRPPW59	01/12/93	2-Butanone	5 U
34858008	CRPPW59	01/12/93	1,1,1-Trichloroethane	1 U
34858008	CRPPW59	01/12/93	Carbon tetrachloride	1 U
34858008	CRPPW59	01/12/93	Bromodichloromethane	16
34858008	CRPPW59	01/12/93	1,2-Dichloropropane	1 U
34858008	CRPPW59	01/12/93	cis-1,3-Dichloropropane	1 U
34858008	CRPPW59	01/12/93	Trichloroethene	1 U
34858008	CRPPW59	01/12/93	Dibromochloromethane	14
34858008	CRPPW59	01/12/93	1,1,2-Trichloroethane	1 U
34858008	CRPPW59	01/12/93	Benzene	1 U
34858008	CRPPW59	01/12/93	trans-1,3-Dichloropropene	1 U
34858008	CRPPW59	01/12/93	Bromoform	3
34858008	CRPPW59	01/12/93	2-Hexanone	5 U
34858008	CRPPW59	01/12/93	4-Methyl-2-pentanone	5 U
34858008	CRPPW59	01/12/93	Tetrachloroethene	1 U
34858008	CRPPW59	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858008	CRPPW59	01/12/93	Toluene	1 U
34858008	CRPPW59	01/12/93	Chlorobenzene	1 U
34858008	CRPPW59	01/12/93	Ethylbenzene	1 U
34858008	CRPPW59	01/12/93	Styrene	1 U
34858008	CRPPW59	01/12/93	Xylenes (total)	1 U
34858008	CRPPW59	01/12/93	1,3-Dichlorobenzene	1 U
34858008	CRPPW59	01/12/93	1,4-Dichlorobenzene	1 U
34858008	CRPPW59	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/15/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858009	CRPPW59D	01/12/93	Chloromethane	1 U
34858009	CRPPW59D	01/12/93	Bromomethane	1 U
34858009	CRPPW59D	01/12/93	Vinyl chloride	1 U
34858009	CRPPW59D	01/12/93	Chloroethane	1 U
34858009	CRPPW59D	01/12/93	Methylene chloride	2 U
34858009	CRPPW59D	01/12/93	Acetone	5 U
34858009	CRPPW59D	01/12/93	Carbon disulfide	1 U
34858009	CRPPW59D	01/12/93	1,1-Dichloroethene	1 U
34858009	CRPPW59D	01/12/93	1,1-Dichloroethane	1 U
34858009	CRPPW59D	01/12/93	cis-1,2-Dichloroethene	1 U
34858009	CRPPW59D	01/12/93	trans-1,2-Dichloroethene	1 U
34858009	CRPPW59D	01/12/93	Chloroform	12 U
34858009	CRPPW59D	01/12/93	1,2-Dichloroethane	1 U
34858009	CRPPW59D	01/12/93	2-Butanone	5 U
34858009	CRPPW59D	01/12/93	1,1,1-Trichloroethane	1 U
34858009	CRPPW59D	01/12/93	Carbon tetrachloride	1 U
34858009	CRPPW59D	01/12/93	Bromodichloromethane	16
34858009	CRPPW59D	01/12/93	1,2-Dichloropropane	1 U
34858009	CRPPW59D	01/12/93	cis-1,3-Dichloropropane	1 U
34858009	CRPPW59D	01/12/93	Trichloroethene	1 U
34858009	CRPPW59D	01/12/93	Dibromochloromethane	14
34858009	CRPPW59D	01/12/93	1,1,2-Trichloroethane	1 U
34858009	CRPPW59D	01/12/93	Benzene	1 U
34858009	CRPPW59D	01/12/93	trans-1,3-Dichloropropene	1 U
34858009	CRPPW59D	01/12/93	Bromoform	2
34858009	CRPPW59D	01/12/93	2-Hexanone	5 U
34858009	CRPPW59D	01/12/93	4-Methyl-2-pentanone	5 U
34858009	CRPPW59D	01/12/93	Tetrachloroethene	1 U
34858009	CRPPW59D	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858009	CRPPW59D	01/12/93	Toluene	1 U
34858009	CRPPW59D	01/12/93	Chlorobenzene	1 U
34858009	CRPPW59D	01/12/93	Ethylbenzene	1 U
34858009	CRPPW59D	01/12/93	Styrene	1 U
34858009	CRPPW59D	01/12/93	Xylenes (total)	1 U
34858009	CRPPW59D	01/12/93	1,3-Dichlorobenzene	1 U
34858009	CRPPW59D	01/12/93	1,4-Dichlorobenzene	1 U
34858009	CRPPW59D	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/15/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34874001	CRPPW60	01/13/93	Chloromethane	1 U
34874001	CRPPW60	01/13/93	Bromomethane	1 U
34874001	CRPPW60	01/13/93	Vinyl chloride	1 U
34874001	CRPPW60	01/13/93	Chloroethane	1 U
34874001	CRPPW60	01/13/93	Methylene chloride	2 U
34874001	CRPPW60	01/13/93	Acetone	21 U
34874001	CRPPW60	01/13/93	Carbon disulfide	150
34874001	CRPPW60	01/13/93	1,1-Dichloroethene	1 U
34874001	CRPPW60	01/13/93	1,1-Dichloroethane	1 U
34874001	CRPPW60	01/13/93	cis-1,2-Dichloroethene	1 U
34874001	CRPPW60	01/13/93	trans-1,2-Dichloroethene	1 U
34874001	CRPPW60	01/13/93	Chloroform	1 U
34874001	CRPPW60	01/13/93	1,2-Dichloroethane	1 U
34874001	CRPPW60	01/13/93	2-Butanone	5 U
34874001	CRPPW60	01/13/93	1,1,1-Trichloroethane	1 U
34874001	CRPPW60	01/13/93	Carbon tetrachloride	1 U
34874001	CRPPW60	01/13/93	Bromodichloromethane	1 U
34874001	CRPPW60	01/13/93	1,2-Dichloropropane	1 U
34874001	CRPPW60	01/13/93	cis-1,3-Dichloropropane	1 U
34874001	CRPPW60	01/13/93	Trichloroethene	1 U
34874001	CRPPW60	01/13/93	Dibromochloromethane	1 U
34874001	CRPPW60	01/13/93	1,1,2-Trichloroethane	1 U
34874001	CRPPW60	01/13/93	Benzene	1 U
34874001	CRPPW60	01/13/93	trans-1,3-Dichloropropene	1 U
34874001	CRPPW60	01/13/93	Bromoform	1 U
34874001	CRPPW60	01/13/93	2-Hexanone	5 U
34874001	CRPPW60	01/13/93	4-Methyl-2-pentanone	5 U
34874001	CRPPW60	01/13/93	Tetrachloroethene	1 U
34874001	CRPPW60	01/13/93	1,1,2,2-Tetrachloroethane	1 U
34874001	CRPPW60	01/13/93	Toluene	1 U
34874001	CRPPW60	01/13/93	Chlorobenzene	1 U
34874001	CRPPW60	01/13/93	Ethylbenzene	1 U
34874001	CRPPW60	01/13/93	Styrene	1 U
34874001	CRPPW60	01/13/93	Xylenes (total)	1 U
34874001	CRPPW60	01/13/93	1,3-Dichlorobenzene	1 U
34874001	CRPPW60	01/13/93	1,4-Dichlorobenzene	1 U
34874001	CRPPW60	01/13/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/25/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34874002	CRPPW55D	01/13/93	Chloromethane	1 U
34874002	CRPPW55D	01/13/93	Bromomethane	1 U
34874002	CRPPW55D	01/13/93	Vinyl chloride	1 U
34874002	CRPPW55D	01/13/93	Chloroethane	1 U
34874002	CRPPW55D	01/13/93	Methylene chloride	2 U
34874002	CRPPW55D	01/13/93	Acetone	32 U
34874002	CRPPW55D	01/13/93	Carbon disulfide	1 U
34874002	CRPPW55D	01/13/93	1,1-Dichloroethene	1 U
34874002	CRPPW55D	01/13/93	1,1-Dichloroethane	1 U
34874002	CRPPW55D	01/13/93	cis-1,2-Dichloroethene	1 U
34874002	CRPPW55D	01/13/93	trans-1,2-Dichloroethene	1 U
34874002	CRPPW55D	01/13/93	Chloroform	1 U
34874002	CRPPW55D	01/13/93	1,2-Dichloroethane	1 U
34874002	CRPPW55D	01/13/93	2-Butanone	5 U
34874002	CRPPW55D	01/13/93	1,1,1-Trichloroethane	1 U
34874002	CRPPW55D	01/13/93	Carbon tetrachloride	1 U
34874002	CRPPW55D	01/13/93	Bromodichloromethane	1 U
34874002	CRPPW55D	01/13/93	1,2-Dichloropropane	1 U
34874002	CRPPW55D	01/13/93	cis-1,3-Dichloropropane	1 U
34874002	CRPPW55D	01/13/93	Trichloroethene	1 U
34874002	CRPPW55D	01/13/93	Dibromochloromethane	1 U
34874002	CRPPW55D	01/13/93	1,1,2-Trichloroethane	1 U
34874002	CRPPW55D	01/13/93	Benzene	1 U
34874002	CRPPW55D	01/13/93	trans-1,3-Dichloropropene	1 U
34874002	CRPPW55D	01/13/93	Bromoform	1 U
34874002	CRPPW55D	01/13/93	2-Hexanone	5 U
34874002	CRPPW55D	01/13/93	4-Methyl-2-pentanone	5 U
34874002	CRPPW55D	01/13/93	Tetrachloroethene	1 U
34874002	CRPPW55D	01/13/93	1,1,2,2-Tetrachloroethane	1 U
34874002	CRPPW55D	01/13/93	Toluene	1 U
34874002	CRPPW55D	01/13/93	Chlorobenzene	1 U
34874002	CRPPW55D	01/13/93	Ethylbenzene	1 U
34874002	CRPPW55D	01/13/93	Styrene	1 U
34874002	CRPPW55D	01/13/93	Xylenes (total)	1 U
34874002	CRPPW55D	01/13/93	1,3-Dichlorobenzene	1 U
34874002	CRPPW55D	01/13/93	1,4-Dichlorobenzene	1 U
34874002	CRPPW55D	01/13/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/25/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34874003	CRPPW61	01/13/93	Chloromethane	1 U
34874003	CRPPW61	01/13/93	Bromomethane	1 U
34874003	CRPPW61	01/13/93	Vinyl chloride	1 U
34874003	CRPPW61	01/13/93	Chloroethane	1 U
34874003	CRPPW61	01/13/93	Methylene chloride	2 U
34874003	CRPPW61	01/13/93	Acetone	14 U
34874003	CRPPW61	01/13/93	Carbon disulfide	1 U
34874003	CRPPW61	01/13/93	1,1-Dichloroethene	1 U
34874003	CRPPW61	01/13/93	1,1-Dichloroethane	1 U
34874003	CRPPW61	01/13/93	cis-1,2-Dichloroethene	1 U
34874003	CRPPW61	01/13/93	trans-1,2-Dichloroethene	1 U
34874003	CRPPW61	01/13/93	Chloroform	1 U
34874003	CRPPW61	01/13/93	1,2-Dichloroethane	1 U
34874003	CRPPW61	01/13/93	2-Butanone	5 U
34874003	CRPPW61	01/13/93	1,1,1-Trichloroethane	1 U
34874003	CRPPW61	01/13/93	Carbon tetrachloride	1 U
34874003	CRPPW61	01/13/93	Bromodichloromethane	1 U
34874003	CRPPW61	01/13/93	1,2-Dichloropropane	1 U
34874003	CRPPW61	01/13/93	cis-1,3-Dichloropropane	1 U
34874003	CRPPW61	01/13/93	Trichloroethene	1 U
34874003	CRPPW61	01/13/93	Dibromochloromethane	1 U
34874003	CRPPW61	01/13/93	1,1,2-Trichloroethane	1 U
34874003	CRPPW61	01/13/93	Benzene	1 U
34874003	CRPPW61	01/13/93	trans-1,3-Dichloropropene	1 U
34874003	CRPPW61	01/13/93	Bromoform	1 U
34874003	CRPPW61	01/13/93	2-Hexanone	5 U
34874003	CRPPW61	01/13/93	4-Methyl-2-pentanone	5 U
34874003	CRPPW61	01/13/93	Tetrachloroethene	1 U
34874003	CRPPW61	01/13/93	1,1,2,2-Tetrachloroethane	1 U
34874003	CRPPW61	01/13/93	Toluene	1 U
34874003	CRPPW61	01/13/93	Chlorobenzene	1 U
34874003	CRPPW61	01/13/93	Ethylbenzene	1 U
34874003	CRPPW61	01/13/93	Styrene	1 U
34874003	CRPPW61	01/13/93	Xylenes (total)	1 U
34874003	CRPPW61	01/13/93	1,3-Dichlorobenzene	1 U
34874003	CRPPW61	01/13/93	1,4-Dichlorobenzene	1 U
34874003	CRPPW61	01/13/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/25/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34874004	CRPPW61D	01/13/93	Chloromethane	1 U
34874004	CRPPW61D	01/13/93	Bromomethane	1 U
34874004	CRPPW61D	01/13/93	Vinyl chloride	1 U
34874004	CRPPW61D	01/13/93	Chloroethane	1 U
34874004	CRPPW61D	01/13/93	Methylene chloride	2 U
34874004	CRPPW61D	01/13/93	Acetone	16 U
34874004	CRPPW61D	01/13/93	Carbon disulfide	1 U
34874004	CRPPW61D	01/13/93	1,1-Dichloroethene	1 U
34874004	CRPPW61D	01/13/93	1,1-Dichloroethane	1 U
34874004	CRPPW61D	01/13/93	cis-1,2-Dichloroethene	1 U
34874004	CRPPW61D	01/13/93	trans-1,2-Dichloroethene	1 U
34874004	CRPPW61D	01/13/93	Chloroform	1 U
34874004	CRPPW61D	01/13/93	1,2-Dichloroethane	1 U
34874004	CRPPW61D	01/13/93	2-Butanone	5
34874004	CRPPW61D	01/13/93	1,1,1-Trichloroethane	1 U
34874004	CRPPW61D	01/13/93	Carbon tetrachloride	1 U
34874004	CRPPW61D	01/13/93	Bromodichloromethane	1 U
34874004	CRPPW61D	01/13/93	1,2-Dichloropropane	1 U
34874004	CRPPW61D	01/13/93	cis-1,3-Dichloropropane	1 U
34874004	CRPPW61D	01/13/93	Trichloroethene	1 U
34874004	CRPPW61D	01/13/93	Dibromochloromethane	1 U
34874004	CRPPW61D	01/13/93	1,1,2-Trichloroethane	1 U
34874004	CRPPW61D	01/13/93	Benzene	1 U
34874004	CRPPW61D	01/13/93	trans-1,3-Dichloropropene	1 U
34874004	CRPPW61D	01/13/93	Bromoform	1 U
34874004	CRPPW61D	01/13/93	2-Hexanone	5 U
34874004	CRPPW61D	01/13/93	4-Methyl-2-pentanone	5 U
34874004	CRPPW61D	01/13/93	Tetrachloroethene	1 U
34874004	CRPPW61D	01/13/93	1,1,2,2-Tetrachloroethane	1 U
34874004	CRPPW61D	01/13/93	Toluene	1 U
34874004	CRPPW61D	01/13/93	Chlorobenzene	1 U
34874004	CRPPW61D	01/13/93	Ethylbenzene	1 U
34874004	CRPPW61D	01/13/93	Styrene	1 U
34874004	CRPPW61D	01/13/93	Xylenes (total)	1 U
34874004	CRPPW61D	01/13/93	1,3-Dichlorobenzene	1 U
34874004	CRPPW61D	01/13/93	1,4-Dichlorobenzene	1 U
34874004	CRPPW61D	01/13/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/25/93

Dilution Factor: 1.0

**VALIDATED DATA FOR OFF-SITE PRIVATE IRRIGATION WELL SAMPLES**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34874005	CRPPW62	01/13/93	Chloromethane	1 U
34874005	CRPPW62	01/13/93	Bromomethane	1 U
34874005	CRPPW62	01/13/93	Vinyl chloride	1 U
34874005	CRPPW62	01/13/93	Chloroethane	1 U
34874005	CRPPW62	01/13/93	Methylene chloride	2 U
34874005	CRPPW62	01/13/93	Acetone	5 U
34874005	CRPPW62	01/13/93	Carbon disulfide	3
34874005	CRPPW62	01/13/93	1,1-Dichloroethene	1 U
34874005	CRPPW62	01/13/93	1,1-Dichloroethane	1 U
34874005	CRPPW62	01/13/93	cis-1,2-Dichloroethene	1 U
34874005	CRPPW62	01/13/93	trans-1,2-Dichloroethene	1 U
34874005	CRPPW62	01/13/93	Chloroform	1 U
34874005	CRPPW62	01/13/93	1,2-Dichloroethane	1 U
34874005	CRPPW62	01/13/93	2-Butanone	5 U
34874005	CRPPW62	01/13/93	1,1,1-Trichloroethane	1 U
34874005	CRPPW62	01/13/93	Carbon tetrachloride	1 U
34874005	CRPPW62	01/13/93	Bromodichloromethane	1 U
34874005	CRPPW62	01/13/93	1,2-Dichloropropane	1 U
34874005	CRPPW62	01/13/93	cis-1,3-Dichloropropane	1 U
34874005	CRPPW62	01/13/93	Trichloroethene	1 U
34874005	CRPPW62	01/13/93	Dibromochloromethane	1 U
34874005	CRPPW62	01/13/93	1,1,2-Trichloroethane	1 U
34874005	CRPPW62	01/13/93	Benzene	1 U
34874005	CRPPW62	01/13/93	trans-1,3-Dichloropropene	1 U
34874005	CRPPW62	01/13/93	Bromoform	1 U
34874005	CRPPW62	01/13/93	2-Hexanone	5 U
34874005	CRPPW62	01/13/93	4-Methyl-2-pentanone	5 U
34874005	CRPPW62	01/13/93	Tetrachloroethene	1 U
34874005	CRPPW62	01/13/93	1,1,2,2-Tetrachloroethane	1 U
34874005	CRPPW62	01/13/93	Toluene	1 U
34874005	CRPPW62	01/13/93	Chlorobenzene	1 U
34874005	CRPPW62	01/13/93	Ethylbenzene	1 U
34874005	CRPPW62	01/13/93	Styrene	1 U
34874005	CRPPW62	01/13/93	Xylenes (total)	1 U
34874005	CRPPW62	01/13/93	1,3-Dichlorobenzene	1 U
34874005	CRPPW62	01/13/93	1,4-Dichlorobenzene	1 U
34874005	CRPPW62	01/13/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/26/93

Dilution Factor: 1.0

**Trip Blanks  
Rinsate Blanks  
Source Water Blanks  
March 1993**

PROJECT: NSB KINGSBAY, GEORGIA  
 PARAMETER : VOLATILE AQUEOUS ANALYSES (ug/l)

VALIDATION SUMMARY TABLE

SAMPLE NUMBER:	BT118FB	BT119FB	BT120FB	BS126ER	BS130ER	BS131ER
LAB NUMBER:	35388K05	35433K01	35442K01	35388002	35433K02	35442K04
DATE SAMPLED:	03/17/93	03/22/93	03/23/93	03/17/93	03/22/93	03/23/93
DATE ANALYZED:	03/23/93	03/29/93	03/30/93	03/23/93	03/29/93	03/30/93
DILUTION FACTOR:	1	1	1	1	1	1

Compound	CRQL						
Chloromethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Vinyl chloride	1	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	2	2 U	2 U	2 U	2 U	2 U	2 U
Acetone	5	5 U	5 U	5 U	33 J	5 U	13
Carbon disulfide	1	1 U	1 U	1 U	2 U	1 U	1 U
1,1-Dichloroethene	1	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone	5	5 U	5 U	5 U	5 U	5 U	5 U
1,1,1-Trichloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Carbon Tetrachloride	1	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	1	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	1	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	1	1 U	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	1	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	1	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	1	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1	1 U	1 U	1 U	1 U	1 U	1 U
2-Hexanone	5	5 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	5	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	1	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	1	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	1	1 U	1 U	1 U	1 U	1	1 U
Ethylbenzene	1	1 U	1 U	1 U	1 U	1 U	1 U
Styrene	1	1 U	1 U	1 U	1 U	1 U	1 U
Xylene (total)	1	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	1	1 U	1 U	1 U	1 U	1 U	1 U

PROJECT: NSB KINGSBAY, GEORGIA  
 PARAMETER : VOLATILE AQUEOUS ANALYSES (ug/l)

VALIDATION SUMMARY TABLE

SAMPLE NUMBER:	BS113FB	BS114FB
LAB NUMBER:	35388003	35388004
DATE SAMPLED:	03/17/93	03/17/93
DATE ANALYZED:	03/23/93	03/23/93
DILUTION FACTOR:	1	1

Compound	CRQL		
Chloromethane	1	1 U	1 U
Bromomethane	1	1 U	1 U
Vinyl chloride	1	1 U	1 U
Chloroethane	1	1 U	1 U
Methylene chloride	2	2 U	2 U
Acetone	5	5 U	5 U
Carbon disulfide	1	1 U	1 U
1,1-Dichloroethene	1	1 U	1 U
1,1-Dichloroethane	1	1 U	1 U
cis-1,2-Dichloroethene	1	1 U	1 U
trans-1,2-Dichloroethene	1	1 U	1 U
Chloroform	1	1 U	34
1,2-Dichloroethane	1	1 U	1 U
2-Butanone	5	5 U	5 U
1,1,1-Trichloroethane	1	1 U	1 U
Carbon Tetrachloride	1	1 U	1 U
Bromodichloromethane	1	1 U	26
1,2-Dichloropropane	1	1 U	1 U
cis-1,3-Dichloropropene	1	1 U	1 U
Trichloroethene	1	1 U	1 U
Dibromochloromethane	1	1 U	15
1,1,2-Trichloroethane	1	1 U	1 U
Benzene	1	1 U	1 U
trans-1,3-Dichloropropene	1	1 U	1 U
Bromoform	1	1 U	2
2-Hexanone	5	5 U	5 U
4-Methyl-2-Pentanone	5	5 U	5 U
Tetrachloroethene	1	1 U	1 U
1,1,2,2-Tetrachloroethane	1	1 U	1 U
Toluene	1	1 U	1 U
Chlorobenzene	1	1 U	1 U
Ethylbenzene	1	1 U	1 U
Styrene	1	1 U	1 U
Xylene (total)	1	1 U	1 U
1,3-Dichlorobenzene	1	1 U	1 U
1,4-Dichlorobenzene	1	1 U	1 U
1,2-Dichlorobenzene	1	1 U	1 U

**Trip Blank**  
**January 1993**

**VALIDATED DATA FOR OFF-SITE TRIP BLANK SAMPLE**

Lab Number	Location	Date Collected	Parameter	Concentration (ug/l)
34858K10	TRIP BLANK	01/12/93	Chloromethane	1 U
34858K10	TRIP BLANK	01/12/93	Bromomethane	1 U
34858K10	TRIP BLANK	01/12/93	Vinyl chloride	1 U
34858K10	TRIP BLANK	01/12/93	Chloroethane	1 U
34858K10	TRIP BLANK	01/12/93	Methylene chloride	2 U
34858K10	TRIP BLANK	01/12/93	Acetone	5 U
34858K10	TRIP BLANK	01/12/93	Carbon disulfide	1 U
34858K10	TRIP BLANK	01/12/93	1,1-Dichloroethene	1 U
34858K10	TRIP BLANK	01/12/93	1,1-Dichloroethane	1 U
34858K10	TRIP BLANK	01/12/93	cis-1,2-Dichloroethene	1 U
34858K10	TRIP BLANK	01/12/93	trans-1,2-Dichloroethene	1 U
34858K10	TRIP BLANK	01/12/93	Chloroform	22
34858K10	TRIP BLANK	01/12/93	1,2-Dichloroethane	1 U
34858K10	TRIP BLANK	01/12/93	2-Butanone	5 U
34858K10	TRIP BLANK	01/12/93	1,1,1-Trichloroethane	1 U
34858K10	TRIP BLANK	01/12/93	Carbon tetrachloride	1 U
34858K10	TRIP BLANK	01/12/93	Bromodichloromethane	1 U
34858K10	TRIP BLANK	01/12/93	1,2-Dichloropropane	1 U
34858K10	TRIP BLANK	01/12/93	cis-1,3-Dichloropropane	1 U
34858K10	TRIP BLANK	01/12/93	Trichloroethene	1 U
34858K10	TRIP BLANK	01/12/93	Dibromochloromethane	1 U
34858K10	TRIP BLANK	01/12/93	1,1,2-Trichloroethane	1 U
34858K10	TRIP BLANK	01/12/93	Benzene	1 U
34858K10	TRIP BLANK	01/12/93	trans-1,3-Dichloropropene	1 U
34858K10	TRIP BLANK	01/12/93	Bromoform	1 U
34858K10	TRIP BLANK	01/12/93	2-Hexanone	5 U
34858K10	TRIP BLANK	01/12/93	4-Methyl-2-pentanone	5 U
34858K10	TRIP BLANK	01/12/93	Tetrachloroethene	1 U
34858K10	TRIP BLANK	01/12/93	1,1,2,2-Tetrachloroethane	1 U
34858K10	TRIP BLANK	01/12/93	Toluene	1 U
34858K10	TRIP BLANK	01/12/93	Chlorobenzene	1 U
34858K10	TRIP BLANK	01/12/93	Ethylbenzene	1 U
34858K10	TRIP BLANK	01/12/93	Styrene	1 U
34858K10	TRIP BLANK	01/12/93	Xylenes (total)	1 U
34858K10	TRIP BLANK	01/12/93	1,3-Dichlorobenzene	1 U
34858K10	TRIP BLANK	01/12/93	1,4-Dichlorobenzene	1 U
34858K10	TRIP BLANK	01/12/93	1,2-Dichlorobenzene	1 U

Date Analyzed: 01/14/93

Dilution Factor: 1.0

## **Appendix C**

### **Precision, Accuracy, Representativeness, Comparability, and Completeness (PARCC) Report for Off-site Analytical Data**



**HEARTLAND ENVIRONMENTAL SERVICES, INC.**

P.O. BOX 163 ST. PETERS MO 63376  
(314) 278-8232

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**PRECISION, ACCURACY, REPRESENTATIVENESS**

**COMPARABILITY, AND COMPLETENESS**

**NSB KINGSBAY**

SDG 34858  
34874

Draft  
Revision 1.1  
February 4, 1993

## **I. Analytical Precision**

Duplicate samples should be evaluated for precision only when contaminants are detected in both the sample and the sample duplicate. However, due to the low Contract Required Quantitation Limits (CRQLs) required in the Scope of Work and the low levels of contamination found at the site, duplicates may not exhibit positive results for all compounds found at or below the SOW CRQL. Those duplicates with Relative Percent Differences (RPDs) within control limits indicate good sampling and analytical precision. Duplicates with RPDs outside the control limits may result from inappropriate sampling procedures, matrix interferences, or non-homogeneity of the sample matrix. In addition, poor precision can be attributed to deviations in the methodology or to poor reproducibility of target analyte concentrations at or near the detection limit (CRQL or IDL).

The acceptance criteria for field duplicates is 20% RPD for water matrices and 35% RPD for soil matrices. The results for the field duplicate precision and duplicate frequency are given in Table 1.1. As shown in this table, all compounds found at concentrations greater than 10X the CRQL (1  $\mu\text{g/L}$ ), are within the RPD limits. The two (2) RPDs that do not meet the RPD limit are at or below the SOW CRQL (5  $\mu\text{g/L}$ ), but above the contractual CRQL for NBS Kingsbay. The RPDs for all compounds found at or below the SOW CRQL are considered to be in control because of the very low concentration of the compounds found in the samples and associated duplicates. No action is required for duplicate precision.

The results of the matrix spike and matrix spike duplicate analysis for volatiles, found in Table 1.2, indicate that all of the RPDs are within QA/QC limits. The acceptable RPDs represent good method performance and little or no matrix interference.

## **II. Analytical Accuracy**

The volatile recovery results for the matrix spike and matrix spike duplicates were all within the QA/QC limits. The accuracy of the results indicate that the method performance was acceptable and the matrix did not interfere with the analysis.

The calibration results for the volatile analyses were in control throughout the duration of the project. As expected, criteria and non criteria calibration compounds did not meet the 30% RSD and 25% D criteria in the calibrations. The volatile calibrations exhibited a loss in sensitivity for two (2) of the ketones. For the compounds in the volatile analysis that did not meet calibration criteria, qualifications were only required for positive results. All positive results that are qualified as estimated (J) due to calibration deficiencies are considered to be useable.

The analytical blanks associated with the volatile analysis contained detectable concentrations of methylene chloride, which are summarized in Table 1.4. Methylene chloride and acetone are common laboratory solvents and are frequently found in laboratory method blanks. Method blank contamination that is observed in the samples is evaluated per the criteria found in the Blank Summary following this narrative. The laboratory contamination noted in the method blanks and the samples is common and does not result in rejection of data.

The one (1) trip blank contained a detectable concentration of one (1) of the trihalomethanes (THMs), chloroform, and a compound that was attributed to method blank contamination. Trihalomethanes are products of the water treatment process and are usually only found in treated water, i.e. treated drinking water. The one (1) trip blank resulted in sample qualification (See Table 1.5). All data qualified for trip blank contamination is considered to be useable. In addition, due to the sample medium and sampling techniques, rinseate blanks and field blanks were not required for this sampling event.

### **III. Analytical Representativeness**

For the volatile analysis, all analysis holding times, tuning criteria, internal standard EICP areas and surrogate recoveries met the QA/QC criteria.

The volatile analyses indicated possible laboratory and/or field contamination for acetone in field samples whose associated method blank was devoid of contamination. Due to the history of the NSB Kingsbay site and the expected contaminants, acetone may or may not be a compound of concern. The acetone results found in the field samples are of low concentration (all less than 23  $\mu\text{g/L}$ ) and may be due to laboratory and/or field contamination. Two (2) samples, CRP-PW59 and CRP-PW59D exhibited positive results for three (3) of the THMs. The THMs can be attributed to the water treatment process. All samples analyzed during this sampling event, except as noted above, are considered to be useable without bias qualifications, either negative or positive.

**IV. Comparability**

ABB Environmental Services did not contract two (2) or more laboratories for this project. Although certain methodologies contain different aspects that can be compared, i.e. TIC results for volatiles with TCL results for semivolatiles, the data generated for this project cannot be compared due to the analysis requested.

**V. Completeness**

Completeness is the quantitative measure of the amount of data obtained from a measurement process compared with the amount expected to be obtained under the conditions of measurement.

The completeness goal for laboratory analysis for this project was 95% useable data. Unusable analytical data are those results reported by the laboratory but rejected during the data validation process. For the private monitoring wells, the analytical completeness was determined to be 100%.

SAMPLE EVENT DATA VALIDATION SUMMARY TABLE					
SDG	PRECISION	ACCURACY	REPRESENT- ATIVENESS	COMPLETENESS	COMPARIBILITY
34858	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	NOT APPLICABLE
34874	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	NOT APPLICABLE

# **PRECISION AND ACCUARCY**

## **FIELD DUPLICATE RESULTS**

**AND**

## **MS/MSD RESULTS**

### **TABLES:**

1.1

1.2

**FIELD DUPLICATE PRECISION - TABLE 1.1  
VOLATILES**

SDG	SAMPLE ID	MATRIX	NO. ASSC. SAMPLES	COMPOUND	SAMPLE CONC.	DUP CONC	MAX RPD	RPD	RPD OUT
34858	CRP-PW59	WATER	8	BROMODICHLOROMETHANE	16	16	20%	0.0%	0
				DIBROMOCHLOROMETHANE	14	14	20%	0.0%	0
				BROMOFORM	3	2	20%	40.0%	1
34874	CRP-PW61	WATER	4	2-BUTANONE	0	5	20%	200.0%	1
% OF DUPLICATES COLLECTED	RPD IN	RPD OUT	% WITHIN RPD LIMIT						
16.7%	2	2	50.0%						

# **MATRIX SPIKE/MATRIX SPIKE DUPLICATE - TABLE 1.2** **VOLATILE SUMMARY TABLE**

MS = MATRIX SPIKE <i>SAMPLE CRP-PW59</i>		SDG 34858					
MSD = MATRIX SPIKE DUPLICATE		MS			MSD		
RPD = RELATIVE PERCENT DIFFERENCE		UNSPIKED	SPIKED	%R	SPIKED	%R	%RPD
<b>VOA COMPOUNDS</b>	<b>UNITS</b>						
1,1-DICHLOROETHENE	ug/L	U	44.90	90	43.40	87	3
TRICHLOROETHENE	ug/L	U	51.90	104	49.30	99	5
BENZENE	ug/L	U	52.40	105	50.10	100	5
TOLUENE	ug/L	U	54.90	110	51.20	102	8
CHLOROBENZENE	ug/L	U	53.90	108	51.80	104	4

\* DENOTES VALUE NOT WITHIN QA/QC ADVISORY LIMITS

## **CORRESPONDING SDG'S WITH ASSOCIATED SAMPLES**

34858: CRP-PW52, CRP-PW53, CRP-PW54, CRP-PW55, CRP-PW56,  
 CRP-PW57, CRP-PW58, CRP-PW59, CRP-WP59D,  
 CRP-PW59MS, CRP-PW59MSD

34874: CRP-PW60, CRP-PW55-D, CRP-PW61, CRP-PW61-D, CRP-PW62

COMPOUND	ADVISORY LIMITS			RPD	
	WATER	SOIL		WATER	SOIL
1,1-DICHLOROETHENE	61%-145%	59%-172%		14	22
TRICHLOROETHENE	71%-120%	62%-137%		14	24
BENZENE	76%-127%	66%-142%		11	21
TOLUENE	76%-125%	59%-139%		13	21
CHLOROBENZENE	75%-130%	60%-133%		13	21

# **CALIBRATION SUMMARY**

## **INITIAL CALIBRATION RESULTS**

### **AND**

## **CONTINUING CALIBRATION RESULTS**

### **TABLES:**

1.3

## VOLATILE ORGANIC COMPOUNDS - TABLE 1.3

### INITIAL AND CONTINUING CALIBRATION - %RSD AND %D

ICAL = INITIAL CALIBRATION = %RSD CCAL = CONTINUING CALIBRATION = %D	SDG 34858		
	ICAL	CCAL1	CCAL2
DATE	010493	011593	011593
INSTRUMENT ID	5100	5100	5100
ACETONE	31.1		33.5
2-HEXANONE		25.9	34.0

#### SDG 34858

CCAL1 011593: VBLKW1, CRP-PW52, CRP-PW53, CRP-PW54, CRP-PW55,  
CRP-PW56, CRP-PW57, CRP-PW58, CRP-PW59

CCAL2 011593: VBLKW2, TRIP BLANK, CRP-PW59D, CRP-PW59MS,  
CRP-PW59MSD

ICAL = INITIAL CALIBRATION = %RSD CCAL = CONTINUING CALIBRATION = %D	SDG 34874		
	ICAL	CCAL1	CCAL2
DATE	012493	012593	012693
INSTRUMENT ID	5100	5100	5100
ACETONE	80.9		38.8
2-HEXANONE		-31.9	28.9
2-BUTANONE		-43.3	
4-METHYL-2-PENTANONE			28.6

#### SDG 34874

CCAL1 012593: VBLKW1, CRP-PW60, CRP-PW55-D, CRP-PW61,  
CRP-PW61D

CCAL2 012693: VBLKW2, CRP-PW62

# **BLANK SUMMARY**

**METHOD BLANK RESULTS**

**TRIP BLANK RESULTS**

**RINSEATE BLANK RESULTS**

**AND**

**FIELD BLANK RESULTS**

## **TABLES:**

**1.4**

**1.5**

## BLANK VALIDATION QUALIFICATIONS CODES

<b>CRQL</b>	<b>=</b>	The related environmental sample result for the blank contaminant is less than the related environmental sample CRQL and is less than 10X the blank value. The related environmental sample result for the contaminant is rejected and the related environmental sample result for that compound is reported at the CRQL as non detect (U). The non detect value at the CRQL will take into account sample weights, volumes, and/or dilutions.
<b>U</b>	<b>=</b>	The related environmental sample result for the blank contaminant is greater than the related environmental sample CRQL and is less than 10X the blank value. The related environmental sample result for the contaminant is qualified as non detect (U) at the compound value reported. The non detect value will take into account sample weights, volumes, and/or dilutions.
<b>NA (No Action)</b>	<b>=</b>	The related environmental sample result for the blank contaminant is greater than the related environmental sample CRQL and is greater than 10X the blank value. The related environmental sample result for the contaminant is considered to be "real", unless otherwise noted in the PARCCs report or associated data validation narrative. qualified as non detect (U) at the compound value reported. The reported value will take into account sample weights, volumes, and/or dilutions.

**VOLATILE METHOD BLANK SUMMARY - TABLE 1.4**

SDG NUMBER	BLANK ID	RELATED ENVIRONMENTAL SAMPLES	CONTAMINANT	MB CONC.	UNITS	VALIDATION QUALIFIER
34858	VBLKW1	CRP-PW52, CRP-PW53, CRP-PW54, CRP-PW55, CRP-PW57, CRP-PW58, CRP-PW59	METHYLENE CHLORIDE	2	ug/L	U
	VBLKW1	CRP-PW56	METHYLENE CHLORIDE	2	ug/L	CRQL
	VBLKW2	CRP-PW59D, CRP-PW59MS, CRP-PW59MSD, TRIP BLANK	METHYLENE CHLORIDE	2	ug/L	U
34874	VBLKW1	CRP-PW60, CRP-PW55-D CRP-PW61, CRP-PW61-D	METHYLENE CHLORIDE	1	ug/L	CRQL
	VBLKW1	CRP-PW60, CRP-PW55-D CRP-PW61, CRP-PW61-D	ACETONE	3	ug/L	U
	VBLKW2	CRP-PW62	METHYLENE CHLORIDE	1	ug/L	



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**PRECISION, ACCURACY, REPRESENTATIVENESS**

**COMPARABILITY, AND COMPLETENESS**

**NSB KINGSBAY**

Draft  
Revision 1.0  
April 15, 1993  
HESI PARCCs Release Number: 3  
Prepared by: Heartland ESI

## **I. Analytical Precision**

Duplicate samples should be evaluated for precision only when contaminants are detected in both the sample and the sample duplicate. However, due to the low Contract Required Quantitation Limits (CRQLs) required in the Scope of Work and the low levels of contamination found at the site, duplicates may not exhibit positive results for all compounds found at or below the SOW CRQL. Those duplicates with Relative Percent Differences (RPDs) within control limits indicate good sampling and analytical precision. Duplicates with RPDs outside the control limits may result from inappropriate sampling procedures, matrix interferences, or non-homogeneity of the sample matrix. In addition, poor precision can be attributed to deviations in the methodology or to poor reproducibility of target analyte concentrations at or near the detection limit (CRQL or IDL).

The acceptance criteria for field duplicates is 20% RPD for water matrices and 35% RPD for soil matrices. The results for the field duplicate precision and duplicate frequency are given in Table 1.1.0.0. As shown in this table, one (1) of the compounds, carbon disulfide, found at a concentration greater than 10X the CRQL (1  $\mu\text{g/L}$ ) is not within RPD control limits. The slightly high RPD (22.2%) can be attributed to the required dilution of the sample, 11G15230 and its duplicate, 11G15230D. The carbon disulfide results in the original undiluted analyses produced a RPD of 9.1%; whereas, the diluted analyses yielded the RPD result of 22.2%. Therefore, the variation in the carbon disulfide results in the diluted samples is most likely due to limited laboratory contamination (as noted in the associated method blanks). No action is required for duplicate precision.

The results of the matrix spike and matrix spike duplicate analysis for volatiles, found in Table 1.2.0.0, indicate that all of the RPDs are within QA/QC limits. The acceptable RPDs represent good method performance and little or no matrix interference.

## **II. Analytical Accuracy**

The volatile recovery results for the matrix spike and matrix spike duplicates were all within the QA/QC limits. The accuracy of the results indicate that the method performance was acceptable and the matrix did not interfere with the analysis.

The calibration results for the volatile analyses were in control throughout the duration of the project. As expected, criteria and non criteria calibration compounds did not meet the 25% D criteria in the calibrations. The volatile calibrations exhibited a loss in sensitivity for three (3) of the ketones. For the compounds in the volatile analysis that did not meet calibration criteria, all positive results that are qualified as estimated (J) due to calibration deficiencies. All results qualified for calibration deficiencies are considered to be useable.

The two (2) of the four (4) analytical blanks associated with the volatile analysis contained detectable concentrations of methylene chloride and carbon disulfide, which are summarized in Table 1.4.0. Methylene chloride and carbon disulfide are common laboratory solvents and are frequently found in laboratory method blanks. Method blank contamination that is observed in the samples is evaluated per the criteria found in the Blank Summary following this narrative. The laboratory contamination noted in the method blanks and the samples is common and does not result in rejection of data.

The three (3) trip blanks did not contain detectable concentrations of TCLs other than compounds that were attributed to method blank contamination. No qualifications were required for trip blank contamination.

The three (3) rinseate blanks contained detectable concentrations of acetone or toluene. Two (2) of the rinseate blanks resulted in sample qualification (see Table 1.6.0). All data qualified for rinseate blank contamination is considered to be usable.

One (1) of the two (2) field blanks contained a detectable concentrations of all four (4) of the trihalomethanes (THMs). Trihalomethanes are products of the water treatment process and are usually only found in treated water, i.e. treated drinking water. The one (1) field blank that contained the THMs did not result in sample qualification. All data is considered to be useable.

### **III. Analytical Representativeness**

For the volatile analysis, all analysis holding times, tuning criteria, internal standard EICP areas and surrogate recoveries met the QA/QC criteria.

The volatile analyses indicated possible laboratory and/or field contamination for carbon disulfide in field samples whose associated method blank was devoid of contamination. Due to the history of the NSB Kingsbay site and the expected contaminants, carbon disulfide may or may not be a compound of concern. The carbon disulfide results found in the three (3) of the field samples, 11G15030, 11G15030MS, and 11G15030MSD, are of low concentration (all 3  $\mu\text{g/L}$ ) and may be due to laboratory and/or field contamination. In addition, one (1) sample, 11G15885 exhibited positive results for chloroform and toluene at low concentration levels, 2  $\mu\text{g/L}$  and 3  $\mu\text{g/L}$  respectively. Chloroform is a THM and is byproduct of the water treatment process; whereas, toluene is a common laboratory contaminant. All samples analyzed during this sampling event, except as noted above, are considered to be useable without bias qualifications, either negative or positive.

#### **IV. Comparability**

ABB Environmental Services did not contract two (2) or more laboratories for this project. Although certain methodologies contain different aspects that can be compared, i.e. TIC results for volatiles with TCL results for semivolatiles, the data generated for this project cannot be compared due to the analysis requested.

#### **V. Completeness**

Completeness is the quantitative measure of the amount of data obtained from a measurement process compared with the amount expected to be obtained under the conditions of measurement.

The completeness goal for laboratory analysis for this project was 95% useable data. Unusable analytical data are those results reported by the laboratory but rejected during the data validation process. For the groundwater monitoring wells, the analytical completeness was determined to be 100%.

<b>SAMPLE EVENT DATA VALIDATION SUMMARY TABLE</b> <b>NSB KINGSBAY</b>					
SDG	PRECISION	ACCURACY	REPRESENT- ATIVENESS	COMPLETENESS	COMPARABILITY
35388	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE
35433	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE
35442	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE

# **PRECISION AND ACCUARCY**

## **FIELD DUPLICATE RESULTS**

**AND**

## **MS/MSD RESULTS**

### **TABLES:**

1.1.0.0

1.2.0.0

# WATER FIELD DUPLICATE PRECISION - TABLE 1.1.0.0

VOLATILE

SDG	SAMPLE ID	MATRIX	NO. ASSC. SAMPLES	COMPOUND	SAMPLE CONC.	DUP CONC	MAX RPD	RPD
35388	11G15230	WATER	2	METHYLENE CHLORIDE	37	41	20%	10.3%
				ACETONE	280	310	20%	10.2%
				CARBON DISULFIDE	200	250	20%	22.2%
				1,1-DICHLOROETHANE	12	14	20%	15.4%
				cis-1,2-DICHLOROETHENE	2	2	20%	0.0%
				2-BUTANONE	440	480	20%	8.7%
				TRICHLOROETHENE	3	3	20%	0.0%
				BENZENE	1	1	20%	0.0%
				2-HEXANONE	19	17	20%	11.1%
				4-METHYL-2-PENTANONE	100	110	20%	9.5%
				TOLUENE	720	840	20%	15.4%
				ETHYLBENZENE	16	18	20%	11.8%
				XYLENES (TOTAL)	62	67	20%	7.8%
35433		WATER	1					
35442		WATER	2					

% OF DUPLICATES COLLECTED	RPD IN	RPD OUT	% WITHIN RPD LIMIT
20.0%	12	1	92.3%

# **WATER MATRIX SPIKE/MATRIX SPIKE DUPLICATE - TABLE 1.2.0.0** **VOLATILE SUMMARY TABLE**

MS = MATRIX SPIKE <i>SAMPLE 11G15030</i>		SDG 35388		
MSD = MATRIX SPIKE DUPLICATE		MS	MSD	
RPD = RELATIVE PERCENT DIFFERENCE		%R	%R	%RPD
<b>VOA COMPOUNDS</b>	<b>UNITS</b>			
1,1-DICHLOROETHENE	ug/L	90	85	6%
TRICHLOROETHENE	ug/L	108	104	4%
BENZENE	ug/L	95	92	3%
TOLUENE	ug/L	88	87	1%
CHLOROBENZENE	ug/L	94	91	3%

\* DENOTES VALUE NOT WITHIN QA/QC ADVISORY LIMITS

## **CORRESPONDING SDG'S WITH ASSOCIATED SAMPLES**

SDG 35388: 11G15030, BS126ER, BS113FB, BS114FB, BT118FB, 11G15230,  
11G15230DL, 11G15230D, 11G15230DDL

SDG 35433: BT119FB, BS130ER, 11G15885, 11G15885DL

SDG 35442: BT120FB, 11G15940, 11G16035, BS1313ER

	WATER		WATER
1,1-DICHLOROETHENE	61%-145%		14
TRICHLOROETHENE	71%-120%		14
BENZENE	76%-127%		11
TOLUENE	76%-125%		13
CHLOROBENZENE	75%-130%		13

# **CALIBRATION SUMMARY**

## **INITIAL CALIBRATION RESULTS AND CONTINUING CALIBRATION RESULTS**

### **TABLES:**

**1.3.0**

## VOLATILE ORGANIC COMPOUNDS - TABLE 1.3.0

INITIAL AND CONTINUING CALIBRATION - %RSD, %D, AND RRF

ICAL = INITIAL CALIBRATION = %RSD	SDG 35388	SDG 35442
CCAL = CONTINUING CALIBRATION = %D	CCAL1	CCAL1
DATE	3/23/93	03/29/93
INSTRUMENT ID	5100	5100
CALIBRATION CRITERIA	%D	%D
ACETONE	37.2	
CHLOROETHANE	-28.2	
BROMOFORM		-28.7
TETRACHLOROETHENE		-33.3
2-BUTANONE		39.0
2-HEXANONE		27.7

### SDGS, STANDARDS, AND ASSOCIATED SAMPLES

#### SDG 35388

CCAL1: BS126ER, BS113FB, BS114FB, BT118FB, 11G15230, 11G15230D

#### SDG 35442

CCAL1: BT120FB, BS131ER, 11G15940, 11G16035

# **BLANK SUMMARY**

**METHOD BLANK RESULTS**

**TRIP BLANK RESULTS**

**RINSEATE BLANK RESULTS**

**AND**

**FIELD BLANK RESULTS**

## **TABLES:**

1.4.0

1.5.0

1.6.0

1.7.0

## **BLANK VALIDATION QUALIFICATIONS CODES**

<b>CRQL</b>	<b>=</b>	The related environmental sample result for the blank contaminant is less than the related environmental sample CRQL and is less than 10X the blank value. The related environmental sample result for the contaminant is rejected and the related environmental sample result for that compound is reported at the CRQL as non detect (U). The non detect value at the CRQL will take into account sample weights, volumes, and/or dilutions.
<b>U</b>	<b>=</b>	The related environmental sample result for the blank contaminant is greater than the related environmental sample CRQL and is less than 10X the blank value. The related environmental sample result for the contaminant is qualified as non detect (U) at the compound value reported. The non detect value will take into account sample weights, volumes, and/or dilutions.
<b>NA (No Action)</b>	<b>=</b>	The related environmental sample result for the blank contaminant is greater than the related environmental sample CRQL and is greater than 10X the blank value. The related environmental sample result for the contaminant is considered to be "real", unless otherwise noted in the PARCCs report or associated data validation narrative. qualified as non detect (U) at the compound value reported. The reported value will take into account sample weights, volumes, and/or dilutions.

## VOLATILE METHOD BLANK SUMMARY - TABLE 1.4.0

SDG NUMBER	BLANK ID	RELATED ENVIRONMENTAL SAMPLES	CONTAMINANT	MB CONC.	UNITS	VALIDATION QUALIFIER
35388	VBLKW1	BS113FB, BS114FB, BT118FB	METHYLENE CHLORIDE	1	ug/L	CRQL
		11G15230, 11G15230D	METHYLENE CHLORIDE	1	ug/L	NA
		BS126ER	CARBON DISULFIDE	2	ug/L	U
		11G15230, 11G15230D	CARBON DISULFIDE	2	ug/L	NA
	VBLKW2	11G15030, 11G15030MS, 11G15030MSD, 11G15230DL, 11G15230DDL	NO CONTAMINATION FOUND			
35433	VBLKW1	11G15885, 11G15885DL, BS130ER, BT119FB	NO CONTAMINATION FOUND			
35442	VBLKW1	11G15940, 11G16035, BS131ER, BT120FB	NO CONTAMINATION FOUND			

# **VOLATILE TRIP BLANK SUMMARY - TABLE 1.5.0**

<b>SDG NUMBER</b>	<b>BLANK ID</b>	<b>RELATED ENVIRONMENTAL SAMPLES</b>	<b>CONTAMINANT</b>	<b>TB CONC.</b>	<b>UNITS</b>	<b>VALIDATION QUALIFIER</b>
35388	BT118FB	11G15030, 11G15030MS 11G15030MSD, 11G15230, 11G15230D	NO CONTAMINATION FOUND			
35433	BT119FB	11G15885	NO CONTAMINATION FOUND			
35442	BT120FB	11G15940, 11G16035,	NO CONTAMINATION FOUND			

## VOLATILE RINSEATE BLANK SUMMARY - TABLE 1.6.0

SDG NUMBER	BLANK ID	RELATED ENVIRONMENTAL SAMPLES	CONTAMINANT	RB CONC.	UNITS	VALIDATION QUALIFIER
35388	BS126ER	11G15230, 11G15230D, 11G15230DL, 11D15230DDL	ACETONE	33	ug/L	NA (NO ACTION)
35433	BS130ER	11G15885	CHLOROBENZENE	1		
35442	BS131ER	11G15940	ACETONE	13	ug/L	CRQL
		11G16035	ACETONE	13	ug/L	U

# **VOLATILE FIELD BLANK SUMMARY - TABLE 1.7.0**

<b>SDG NUMBER</b>	<b>BLANK ID</b>	<b>RELATED ENVIRONMENTAL SAMPLES</b>	<b>CONTAMINANT</b>	<b>FB CONC.</b>	<b>UNITS</b>	<b>VALIDATION QUALIFIER</b>
35388	BS113FB	11G15030, 11G15030MS, 11G15030MSD, 11G15230, 11G15230D	NO CONTAMINATION FOUND			
	BS114FB	11G15030, 11G15030MS, 11G15030MSD, 11G15230, 11G15230D	CHLOROFORM BROMODICHLOROMETHANE CHLORODIBROMOMETHANE BROMOFORM	34 26 15 2	ug/L	

# **VOLATILE TRIP BLANK SUMMARY - TABLE 1.5**

<b>SDG NUMBER</b>	<b>BLANK ID</b>	<b>RELATED ENVIRONMENTAL SAMPLES</b>	<b>CONTAMINANT</b>	<b>TB CONC.</b>	<b>UNITS</b>	<b>VALIDATION QUALIFIER</b>
34858	TRIP BLANK	CRP-PW59, CRP-PW59D	CHLOROFORM	22	ug/L	U